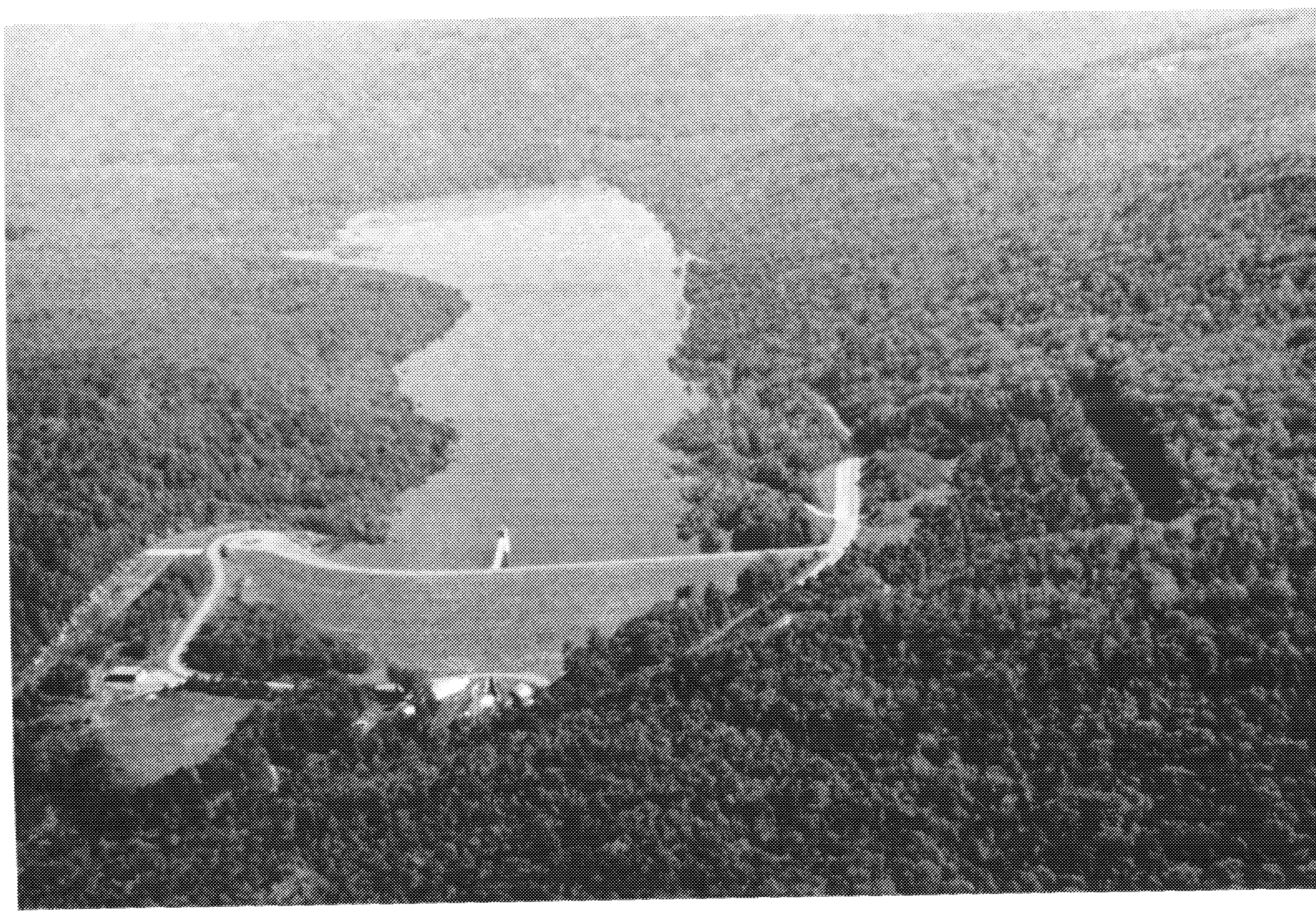
US Army Corps
of Engineers
New England Division

Drought Contingency Plan

AUGUST 1992

Otter Brook Lake, Keene, New Hampshire



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This report set forth an emergency drought contingency storage plan for operation of Otter Brook Lake that would identify how the New England Division could render assistance to the State of New Hampshire during State declared drought emergencies affecting domestic, municipal and industrial water supplies. Included in this study is a description of: present operating regulations; existing water supply conditions; impacts on other project purposes; the plan for utilization of short term emergency storage during a drought; cost for drought storage/releases; an evaluation of water quality.

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SUMMARY

DROUGHT CONTINGENCY STORAGE FOR EMERGENCY WATER SUPPLY PURPOSES AT OTTER BROOK LAKE IS SPONSORED BY THE STATE OF NEW HAMPSHIRE.

In letter, dated September 13, 1991 (copy in Appendix D), the State of New Hampshire Department of Environmental Services has identified themselves as the lead Agency to act as sponsor for the Otter Brook Lake Drought Contingency Plan.

Requirements for Environmental Compliance Prior to Implementation of Drought Contingency Plan

Prior to implementation of drought contingency storage, an updated Environmental Assessment (EA) will be prepared in accordance with the National Environmental Policy Act (NEPA) of 1969. The existing EA, prepared in 1973, does not address the environmental impacts related to this drought contingency plan. The new assessment will address impacts to water quality, wetlands, aquatic and terrestrial habitats and historic as well as archeological resources resulting from storage of water during a drought emergency. In addition, the new assessment will analyze compliance of the proposed action with Federal, State and local environmental regulations and will be coordinated with appropriate Federal and State Agencies. This requirement to prepare an Environmental Assessment must be fulfilled even in the event of a declared drought emergency.

DROUGHT CONTINGENCY PLAN
OTTER BROOK LAKE

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DROUGHT CONTINGENCY PLAN
OTTER BROOK LAKE

1. PURPOSE AND SCOPE

The purpose of this study and report was to develop and set forth an emergency drought contingency storage plan for operation of Otter Brook Lake that would identify how the New England Division could render assistance to the State of New Hampshire during State declared drought emergencies affecting domestic, municipal and industrial water supplies. The scope of this report was not to address the feasibility of providing a permanent water supply pool at Otter Brook Lake, but rather to address the use of a temporary short term pool during a drought emergency. The scope was to identify possible modifications to project regulations within current administrative and legislative constraints. Assistance would be provided through flexibility of regulation and use of existing storage at Otter Brook Lake. Such operation is considered to be within the existing approved water control plan for this project. Included are a description of: present operating regulations; existing water supply conditions; the plan for utilization of short term emergency storage during a drought; an evaluation of water quality; cost for drought storage/releases; impacts on other project purposes; identification of a State sponsor and a conclusion.

2. AUTHORIZATION

The authority for drought contingency plans is contained in ER 1110-2-1941, dated 15 September 1981, which provides that water control managers continually review and when appropriate, adjust water control plans in response to changing public needs. Drought contingency plans will be developed on a regional, basin-wide or project basis as an integral part of water control management activities and in accordance with an approved water control plan.

3. PROJECT AUTHORIZATION CONDITIONS

Otter Brook Lake was authorized by the Flood Control Act approved 3 September 1954 (Public Law 780, 83rd Congress) which modified the act of 1936 as amended and supplemented it to provide for the construction of the flood control reservoir on the Otter Brook at South Keene, New Hampshire. The project is included in the Flood Control Compact adopted by the States of Connecticut, Massachusetts, Vermont and New Hampshire and approved 6 June 1963.

4. PROJECT DESCRIPTION

Otter Brook Lake, constructed in 1958, is located on Otter Brook, a tributary of the Ashuelot River, in the city of Keene, New Hampshire. Prior to 1974, a pool was maintained at elevation 701.0 feet NGVD (18 foot depth) during the summer season. During the winter months, the pool was raised to elevation 703.0 feet NGVD so that the outlet gates would be submerged to prevent freezing. From 1974 to present, a permanent pool is maintained year round at elevation 703.0 feet NGVD (20 foot depth) having a surface area of 76 acres and a total storage of 870 acre-feet of water. The pool is maintained year round for ease of operation and represents an infringement into flood control storage of only 0.06 inches of runoff from its watershed. The reservoir has a total flood storage capacity of 17,600 acre-feet above the previous recreation pool level of 701.0 feet NGVD up to spill-way crest elevation 781.0 feet NGVD, equivalent to 7.0 inches of runoff from the 47 square mile drainage area. Area-capacity data for Otter Brook Lake is shown on plate 2.

The outlet works consist of a 6-foot diameter conduit with an invert elevation at 683.0 feet NGVD. Flow through the outlet is controlled by three 2'-6" by 4'-6" hydraulically operated slide gates. A permanent concrete weir containing five stoplog openings is located upstream of the center gate and maintains the summer pool.

5. PRESENT OPERATING REGULATIONS

a. <u>Normal Periods</u>. A 20-foot deep permanent pool is maintained by the concrete weir and stoplog structure located upstream of the center gate. The pool is maintained at elevation 703.0 feet NGVD. During periods of normal flow, outflow is maintained equal to inflow by allowing all inflow to pass through the dam.

b. <u>Flood Periods</u>. Otter Brook Lake is operated in concert with other projects in the basin to reduce flooding downstream on Otter Brook, the Branch, the Ashuelot Rivers and further downstream on the Connecticut River. Operations for floods may be considered in three phases: Phase I - appraisal of storm and river conditions during development of the flood; Phase II - flow regulation and storage of flood runoff at the reservoir; and Phase III - emptying the reservoir following downstream recession of the flood. A minimum release of about 10 cfs is maintained <u>only</u> during periods of flood control regulation in order to sustain downstream fish life. The maximum non-damaging discharge capacity immediately downstream of Otter Brook Lake is about 650 cfs.

Releases at or near this rate can be expected whenever peak inflows have exceeded this value and climatologic and hydrologic conditions permit such releases.

c. Monitoring. The Reservoir Control Center (RCC) directs the reservoir regulation activities at 28 manned New England Division flood control dams and continually monitors rainfall, snow cover and runoff conditions throughout the region. When any of these hydrologic parameters have been observed to be well below normal for several months and it appears that possible drought conditions might be developing, the Corps Emergency Operations Center (EOC) will be informed. The EOC will then initiate discussions with the respective Federal and State agencies and other in-house Corps elements to review possible drought concerns and future Corps actions.

6. DESCRIPTION OF EXISTING WATER SUPPLY CONDITIONS

a. General. The area of concern is extreme southwestern portion of New Hampshire, lying entirely within Cheshire County. Table 1 contains information about public water suppliers in the area based on information provided by the New Hampshire Water Supply and Pollution Control Commission. The information was taken from the Facilities and Policy Summary published in 1981. Of the 13 communities in the study area, portions of seven are served by a public water supply system. No data is available for those communities dependent on private individual supplies.

b. Water Supply Systems. The primary objective of this analysis was to accumulate available data regarding water supply systems in the vicinity of Otter Brook Lake that could benefit from storage in the lake and present it in a manner portraying existing water supply conditions. Projections of future demands were not developed because this study only addresses the effects of drought conditions which could occur at any time in the future. Modifications in the operational procedures at Otter Brook Lake would provide storage for water supply purposes only when drought conditions exist and not to meet normal water supply demands at some future date.

c. Southwestern New Hampshire Water Suppliers. As noted in table 1, the data given for each water supplier includes: community served; estimated population served by the system; source of supply (ground or surface water); average day and maximum day demands for 1980; and the estimated safe yield of each source where available. An analysis of the adequacy of existing sources during drought conditions was not performed. The information has been accumulated to present a summary of the existing water supply conditions for area communities in the vicinity of Otter Brook Lake.

TABLE 1
PUBLIC WATER SUPPLIERS - SOUTHWESTERN NEW HAMPSHIRE

COMPANY OR AGENCY	TOWN SERVED	EST. POPULATION SERVED - 1981	SOURCE OF SUPPLY SW/GW	1981 DEMAND AVG. DAY (MGD)	1981 DEMAND MAX. DAY (MGD)	SUPPLY SOURCE	SAFE YIELD (MGD)
	Chesterfield		No Public Water Supply				
	Gilsom		No Public Water Supply				
Hinsdale Water & Sewer Works	Hinsdale	3,000	GW	.667	.840	GP Well (Two)	0.60
Keene Water Works	Keene	25,000	GW/SW	3.314	5.117	Babbidge Dam	2.30
						GP #1 West	0.75
						GP #2 Court St.	1.00
						GP #3 Court St.	1.00
						GP #4 Court St.	1.00
Marlboro Water Works	Marlboro	348	GW	No Meter		GP #1 School St. (Aux)	--
						GP #2 Fitch Court	--
	Richmond		No Public Water Supply				
	Roxbury	(60 Connections)				Keene Water Works	
	Sullivan		No Public Water Supply				
	Surry		No Public Water Supply				
North Swanzey Water Dept.	Swanzey	(380 Connections)				Keene Water Works	
Troy Water Works	Troy	1,200	GW/SW	.420	.480	Fassett Brook	--
						BR Well	--
	Westmoreland		No Public Water Supply				
Winchester Water Dept.	Winchester	2,500	GW	.537	.600	GP #1 Keene Rd.	0.32
						GP #2 Keene Rd.	0.46
						GP #3 Richmond Rd.	1.15

d. <u>Population Projections</u>. Population projections for communities in the vicinity of Otter Brook Lake are given in table 2 to show the population trends for each community potentially affected by a prolonged dry period. The projections for these communities were provided by the New Hampshire Office of State Planning which developed population projections statewide from criteria the Corps of Engineers used for projecting populations in the southwestern New Hampshire Water Resources Study. This information indicates areas of potential future growth in the southwestern New Hampshire area.

7. SPONSOR

a. <u>General</u>. In an effort to make the Drought Contingency Plans fully implementable it is required to identify a local sponsor. If a local sponsor is not found, then the plan will be considered inactive and drought storage at the Corps Dam will not be studied. The approach is for a State to enter into a contract with the Secretary of the Army (or his representative) and to agree to act as wholesaler for all of the water requirements of individual users. This places local governments in a position to help their citizens during difficult times and minimize the potential problems that could arise if the Secretary of the Army was to determine who was entitled to shares of drought emergency water based on assessments of local needs. The sponsor is required to express an interest in utilizing short term storage at the Corps reservoir for emergency water supply and/or other instream flow requirements. By expressing interest, the sponsor will be required to enter into an emergency water supply contract specifying the potential water supply available and the costs associated with emergency water supply releases from the Corps project.

b. <u>Otter Brook Lake Sponsor</u>. In accordance with a letter dated September 13, 1991, the State of New Hampshire, Department of Environmental Services (DES), has identified themselves as the lead Agency to act as the sponsor for the Otter Brook Lake Drought Contingency Plan. A copy of the letter, as well as the Draft Emergency Drought Contingency Water Supply Contract, are presented in appendix D.

During discussions with New Hampshire DES it was determined that the primary user of drought storage at Otter Brook Lake would most likely be the city of Keene, located downstream of Otter Brook Lake along the Ashuelot River. The Keene water supply system has a current peak demand of about 5.0 MGD (8 cfs), which is equivalent to the safe yield. This

TABLE 2
POPULATION PROJECTIONS - SOUTHWESTERN NEW HAMPSHIRE

TOWN	Actual 1980	1985	1990	1995	2000	Percent Change
Chesterfield	2,559	2,939	3,372	3,823	4,169	62.9
Gilsum	643	706	750	787	813	26.4
Hinsdale	3,632	3,584	3,736	3,789	3,827	5.4
Keene	21,385	21,782	21,901	22,088	22,400	4.7
Marlboro	1,850	1,963	2,054	2,130	2,188	18.3
Richmond	516	598	690	792	871	68.8
Roxbury	193	208	224	238	248	28.5
Sullivan	585	678	782	898	988	68.9
Surry	662	767	885	1,016	1,118	68.9
Swanzey	5,179	5,712	6,293	6,916	7,395	42.8
Troy	2,128	2,320	2,526	2,738	2,899	36.2
Westmoreland	1,448	1,675	1,899	2,156	2,372	63.8
Winchester	3,440	3,612	3,793	3,965	4,084	18.7
	44,220	46,644	48,905	51,336	53,372	20.7

information was received in 1990 from the city of Keene and is an update to those values indicated in table 1.

c. State and Local Contingency Planning. In the event of a declaration of a water supply emergency in the area of Otter Brook Lake by the Governor or otherwise according to law, the State of New Hampshire would initiate a set of procedures in order to ensure a constant supply of water to needed communities. Guidance for these procedures is provided in the New Hampshire Drought Management Plan (DMP) (May 1990) prepared by the Department of Environmental Services (DES) Water Resources Division. These regulations require public water suppliers to develop drought contingency plans for their system. The Drought Management Plan has been developed based on the following four levels:

(1) Level 1 - Alert. At this level a detailed assessment of hydrologic conditions relative to a specific source or use should be conducted if not already done. This assessment should include a projection into the future to determine the potential need for voluntary or mandatory action.

(2) Level 2 - Warning. Voluntary water conservation measures are initiated to prevent serious shortages. Investigation of potential source augmentation may be undertaken. The need for mandatory action is evaluated.

(3) Level 3 - Emergency. Mandatory water conservation measures are implemented. Generally these conservation measures relate to nonessential water use.

(4) Level 4 - Disaster. At this point, water restrictions may be imposed which have significant economic implications. Emergency powers of the Governor may be exercised to mitigate severe local impacts.

Levels 1 through 3 correspond to Phase I - Drought Watch, described below in paragraph 8e(1). Level 4 would be activated by a declaration of water supply emergency and coincides with Phase II - Drought Emergency described below in paragraph 8e(2).

8. PROPOSED ASSISTANCE PLAN

a. General. There are several authorities that provide for the use of reservoir storage for water supply at Corps of Engineers projects. They vary from the provisions of water supply storage as a major purpose in new projects to the discretionary authority to provide emergency supplies to local communities in need. Under authority of ER 1110-2-1941 New England Division is directed to determine the short term water supply capability of their existing reservoirs that would be functional under existing authorities. Congressional authorization is not required to add municipal and industrial water supply if the related revisions in regulation would not significantly affect operation of the project for the originally authorized purposes.

b. Otter Brook Lake Plan

(1) There is no storage allocated for water supply at Otter Brook Lake, therefore, the only existing drought assistance capability would be through increased flexibility of regulation and short term use of project authorized storage. It was determined that the pool can be raised to elevation 705.0 feet NGVD to provide short term drought emergency assistance without compromising the flood control purpose of the project nor significantly impacting the recreational aspects of the project. It was further determined that drawdown of the pool from 705.0 to the top of the permanent pool elevation of 703.0 be used for drought emergency water supply. A pool of 705.0 represents a volume of about 160 acre feet (52 million gallons) over a pool elevation of 703.0 feet NGVD.

(2) It is noted that this current Otter Brook Lake drought contingency plan recommends a drought pool elevation of 705.0 feet NGVD, which is 3 feet lower than the pool established in the earlier 1984 report. The lower elevation, established in this current plan, is based on determinations of the least significant impact to recreation activities and subsequent mitigation costs. At elevation 708.0 feet NGVD, the existing beach area at Otter Brook Lake would be innundated and not available for use; however, at elevation 705.0 feet NGVD, the beach could still be used. Mitigation costs were kept to a minimum by minimizing the extent of innundating the beach area. The current plan as developed is believed to be the most appropriate, providing a reasonable amount of emergency water supply with the least amount of cost to the State of New Hampshire, as well as least impact to project recreation activities.

(3) As the extent of Corps assistance is limited to the time of year drought conditions exist, it is anticipated that there would be enough forewarning to fill the reservoir in the May-June timeframe. By filling the drought pool in this timeframe, the Corps would be in a position to render assistance during the proceeding historic low flow summer months (July-October timeframe). Based on the May-June low

flow duration analysis, it was determined that during a 10-year frequency drought there would be sufficient riverflow to fill the reservoir from the permanent pool to the drought pool in about a 23-day period. During this filling period, a minimum release rate from the dam of about 7 cfs (7Q10 for the May-June timeframe) or inflow, whichever is less, would be maintained whenever possible.

(4) Once the water was stored at the drought pool level and a "declared" drought emergency exists, as well as a water supply contract signed between the Corps and the State of New Hampshire, releases would be made from the project upon requests from New Hampshire DES. It is anticipated that releases would be in addition to passing all inflow through the dam and would occur during the July-October timeframe and would continue until the pool level was lowered to 703.0 elevation pool level. During this drawdown, any recovery of water supply storage will be made if conditions permit. Once the pool level reaches 703.0 feet NGVD, New England Division would decide whether additional releases could be made to further draw down the reservoir into the permanent pool. If no additional drawdown releases are feasible, then all inflow will be passed through the dam to hold the 703.0 feet NGVD pool elevation.

(5) If assistance is requested outside the May-June timeframe, the time to fill, as well as the risk associated with providing flood protection, would have to be decided by New England Division prior to any initiation of drought storage operation. It is assumed that some variation of the drought procedure mentioned above would be possible to render assistance regardless of the time of year. Minimum release rates (generally equal to the seasonal 7Q10), as well as drought pool filling durations, would vary depending on the season of the year assistance is needed. Drought contingency storage versus flow duration at Otter Brook Lake is shown graphically on plate 3.

c. <u>Water Shortage Indicators</u>. The Reservoir Control Center (RCC) of the New England Division will keep abreast of current hydrologic as well as climatologic data at all Corps projects in an effort to aid in the recognition of the onset of dry or drought conditions. A series of guide curves have been developed as a tool in this recognition process. Curves such as rainfall-duration-frequency and minimum-surface runoff-frequency were developed for various index stations throughout New England. Index stations selected were based on proximity to Corps reservoirs, period of record and reliability of data. The guide curves were developed and compared with historic drought data as a way to "track" current observed conditions with comparable historic conditions. Appendix A presents the guide curves with an explanation of their development and use. Also presented in Appendix A is the Palmer Drought Severity Index (PDSI) classification chart with available New England historic index levels indicated.

As data is monitored by RCC, it will be used with these guide curves, as well as supplemental information received from various Federal and State Agencies, prior to making a decision to store emergency drought water at Otter Brook Lake.

d. <u>Emergency Operations Center (EOC)</u>. As RCC collects and monitors climatologic and hydrologic data associated with dry or drought conditions, the New England Division EOC will be informed. The EOC will initiate discussions with in-house Corps elements as well as with other respective Federal and State Agencies to review possible drought concerns and future Corps actions. For Otter Brook Lake, the lead State Agency coordination would be initiated with is:

Department of Environmental Services
Office of the Commissioner
6 Hazen Drive, PO Box 95
Concord, New Hampshire 03302
Tel.#: (603) 271-3503

All decisions regarding any Corps action during dry or drought conditions will be made by the EOC.

e. <u>Phases of Drought Assistance</u>. Drought assistance from the Corps Otter Brook Lake will be given in two phases. Phase I will be during "drought watch" conditions existing within the Otter Brook Lake region of New Hampshire and Phase II - drought emergency is declared by the State of New Hampshire. Phases I and II are explained below.

(1) <u>Phase I - Drought Watch</u>. This is the initial phase of implementation of drought assistance. The following conditions and actions will take place during this phase:

(a) Initial indications conclude that a drought condition is developing within this region of New Hampshire. Close coordination between New England Division and other Federal and State agencies, in addition to coordination efforts within New England Division's EOC, has identified that a drought condition is beginning (refer to appendix A for climatologic and hydrologic guide curves of precipitation as well as surface runoff data). This coordination will insure that actions being taken, as well as all decisions, are targeted to meet specific needs and not to react prematurely.

(b) Pending coordination with the New Hampshire Department of Environmental Services and their subsequent concurrence with the Corps to store water at Otter Brook Lake, and subject to the availability of inflow, Otter Brook Lake will be filled to elevation 705.0 feet NGVD.

(c) The water will be stored at this level and outflow will be set equal to inflow in order to maintain the pool at a constant level. This pool will be maintained until the New Hampshire DES formally requests emergency water supply releases be made. This will take place during the drought emergency phase. Release rates would then be equivalent to inflow plus water supply demand (as requested by DES).

(2) <u>Phase II - Drought Emergency</u>

(a) A declaration of a drought emergency has been issued by the Governor of New Hampshire, or otherwise according to law and issued by the New Hampshire DES.

(b) Department of Environmental Services contacts New England Division and requests that releases, of a specific amount, be made.

(c) Division Engineer convenes a meeting with Emergency Operations Center to discuss request.

(d) If emergency water supply releases are to be made, a target release rate will be determined by New England Division. This rate will include the natural inflow to the reservoir as well as the water supply release rate requested by DES. Prior to any releases made, the water supply contract will be signed by the Corps and the State of New Hampshire.

(e) Drawdown of the pool will continue until the pool is lowered to the 703.0 elevation. At that time New England Division will decide if continued releases could be made to draw down further into the permanent pool. During drawdown operations, any recovery of water supply storage will be made if conditions permit.

f. <u>Compensation for Use of Storage</u>. As directed by ER 1105-2-100 dated 28 December 1990, compensation must be received for all "emergency drought releases." This compensation will be at least equal to a proper share of annual joint use O&M costs and major replacement expenses plus revenues foregone as well as any other costs directly attributable to making releases. For Otter Brook Lake, an approximate cost of $ 2,614 has been determined for the release of about 160 acre feet of drought assistance water based on 1991 dollars. Appendix B presents the Economic Assessment of Drought Contingency Water Supply Pricing at Otter Brook. Said costs are also identified in the draft water supply contract located in appendix D.

9. DISCUSSION OF IMPACTS

a. General. Any action resulting in a temporary change of reservoir storage volumes will have impacts on authorized project purposes, which must be evaluated as part of the drought storage implementation plan. At Otter Brook Lake, the drought contingency plan is one component of the total water control plan. Presented below, is a cursory evaluation of the impacts resulting from drought contingency storage on flood control and recreation purposes of the project. Effects on environmental as well as historic and archaeological resources will be addressed at such time when an updated Environmental Assessment (EA) for the complete operation of the project has been completed. For purposes of this drought contingency plan, the existing EA, prepared in October 1973, supporting the current approved water control plan, will be used.

b. Flood Control. A review of the regulation procedures at Otter Brook Lake was undertaken to determine the volume of water that could be made available for emergency drought contingency purposes. The water would be stored by temporarily utilizing existing flood control storage. It is recognized that major floods occur in every season of the year and any use of flood control storage would be continually monitored to insure there would be no adverse impacts on downstream flood protection.

At Otter Brook Lake, the maximum pool elevation for drought contingency storage has been estimated to be elevation 705.0 feet NGVD, representing an infringement on flood control storage of about 0.1 inch, out of the total capacity of 7.0 inches, of runoff from the upstream drainage area of 47 square miles. This level represents the approximate elevation to which water could be stored without significantly affecting flood control capability or other regulation activities.

c. <u>Recreation</u>. The existing beach area would be affected as a result of raising the pool level to elevation 705 feet NGVD. Approximately one-half of the beach area would be inundated at this pool level. While the beach area could still be used at the drought storage pool level, additional maintenance, as well as periodic buoy movements and beach raking/cleaning would be incurred during drawdown operations. Compensation for these additional costs have been accounted for in the economic appendix.

d. <u>Water Quality</u>. Drought contingency storage at Otter Brook Lake would raise the pool 2.0 feet above the permanent pool of 703.0, to 705.0 feet NGVD, from a maximum depth of 20 to 22 feet. This increase would only occur during a declared drought period. Water quality effects that could result from drought storage include decreases in dissolved oxygen and increases in water temperature, iron, manganese, phosphorus, ammonia, color and suspended solids. These increases would be minor and are not expected to threaten aquatic life or human health. Although the lake would be subject to a greater potential for the occurrence of localized algae blooms, severe algae problems are not anticipated and trophic status of the lake should remain unchanged. Effects of drought storage operations on downstream water quality are expected to be minimal as well. The waters of Otter Brook Lake would require standard treatment processes for drinking water supply, but no treatment would be necessary for fire-fighting, irrigation and most industrial uses in the event of drought storage implementation. Appendix C presents a comprehensive water quality evaluation regarding drought contingency storage at Otter Brook Lake.

10. CONCLUSIONS

A drought contingency plan was developed for Otter Brook Lake that would be responsive to public needs during drought situations. The plan would permit encroachment on flood control storage up to elevation 705 feet NGVD, providing an emergency water supply contingency of about 160 acre-feet (52 million gallons) over the permanent pool elevation of 703.0 feet NGVD. The State of New Hampshire has agreed to sponsor the implementation of this plan during times of drought emergency.

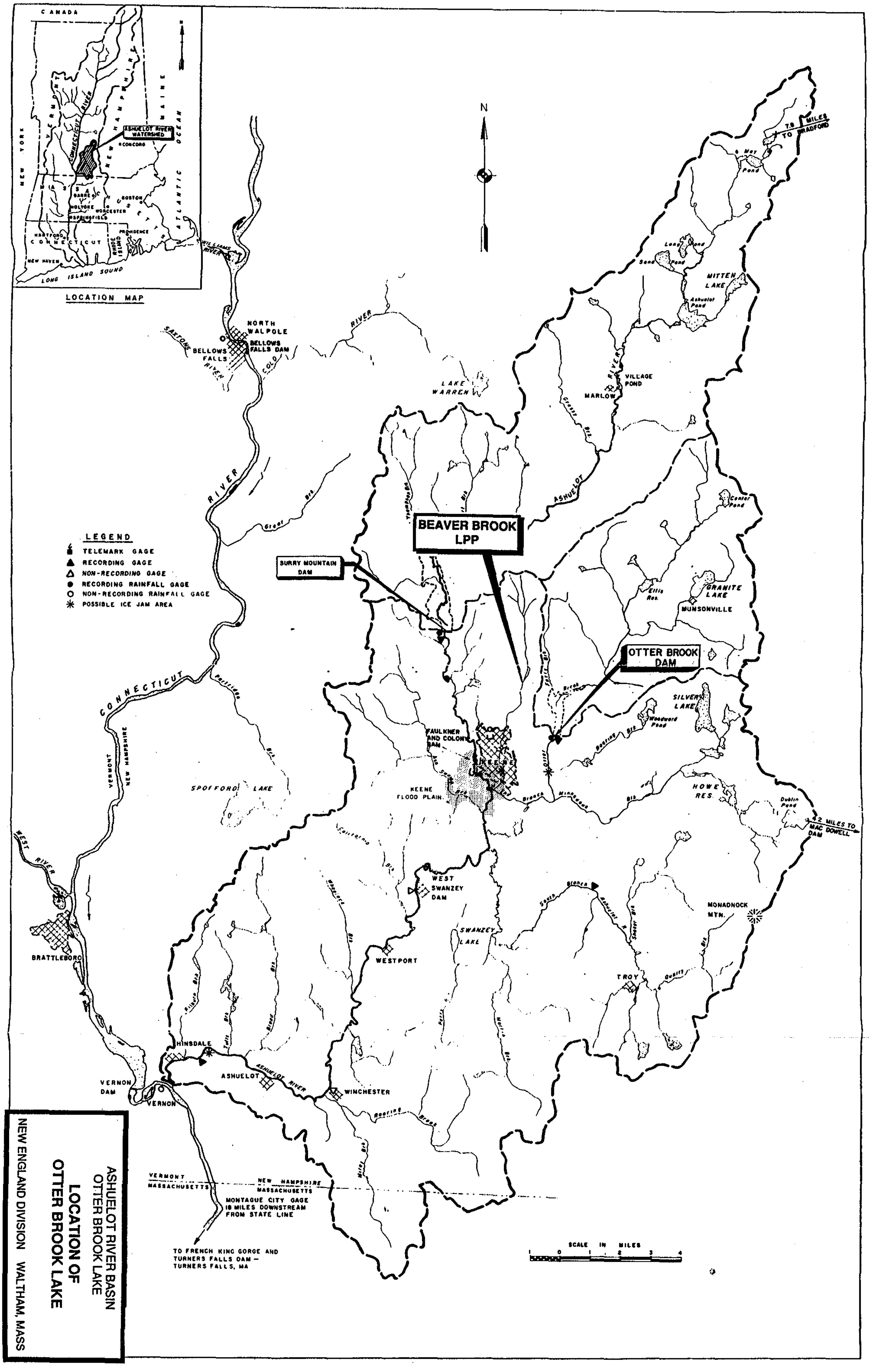

LOCATION MAP
CANADA
VERMONT
NEW HAMPSHIRE
MAINE
NEW YORK
MASSACHUSETTS
CONNECTICUT
RHODE ISLAND
ATLANTIC OCEAN
LONG ISLAND SOUND
CONNECTICUT RIVER
ASHUELOT RIVER WATERSHED
CONCORD
BOSTON
WORCESTER
BARRE
HOLYOKE
SPRINGFIELD
HARTFORD
PROVIDENCE
NEW HAVEN
N
LEGEND
TELEMARK GAGE
RECORDING GAGE
NON-RECORDING GAGE
RECORDING RAINFALL GAGE
NON-RECORDING RAINFALL GAGE
POSSIBLE ICE JAM AREA
BEAVER BROOK LPP
SURRY MOUNTAIN DAM
OTTER BROOK DAM
NORTH WALPOLE
BELLOWS FALLS DAM
BELLOWS FALLS
SAXTONS RIVER
COLD RIVER
LAKE WARREN
MARLOW
VILLAGE POND
MITTEN LAKE
Ashuelot Pond
78 MILES TO BRADFORD
GRANITE LAKE
MUNSONVILLE
SILVER LAKE
HOWE RES.
Dublin Pond
42 MILES TO MAC DOWELL DAM
FAULKNER AND COLONY DAM
KEENE
KEENE FLOOD PLAIN
SPOFFORD LAKE
CONNECTICUT RIVER
WEST RIVER
VERMONT
NEW HAMPSHIRE
BRATTLEBORO
WEST SWANZEY DAM
SWANZEY LAKE
WESTPORT
MONADNOCK MTN.
TROY
HINSDALE
ASHUELOT
ASHUELOT RIVER
WINCHESTER
VERNON DAM
VERNON
VERMONT
MASSACHUSETTS
NEW HAMPSHIRE
MASSACHUSETTS
MONTAGUE CITY GAGE 18 MILES DOWNSTREAM FROM STATE LINE
TO FRENCH KING GORGE AND TURNERS FALLS DAM - TURNERS FALLS, MA
SCALE IN MILES
1 0 1 2 3 4
ASHUELOT RIVER BASIN
OTTER BROOK LAKE
LOCATION OF
OTTER BROOK LAKE
NEW ENGLAND DIVISION WALTHAM, MASS

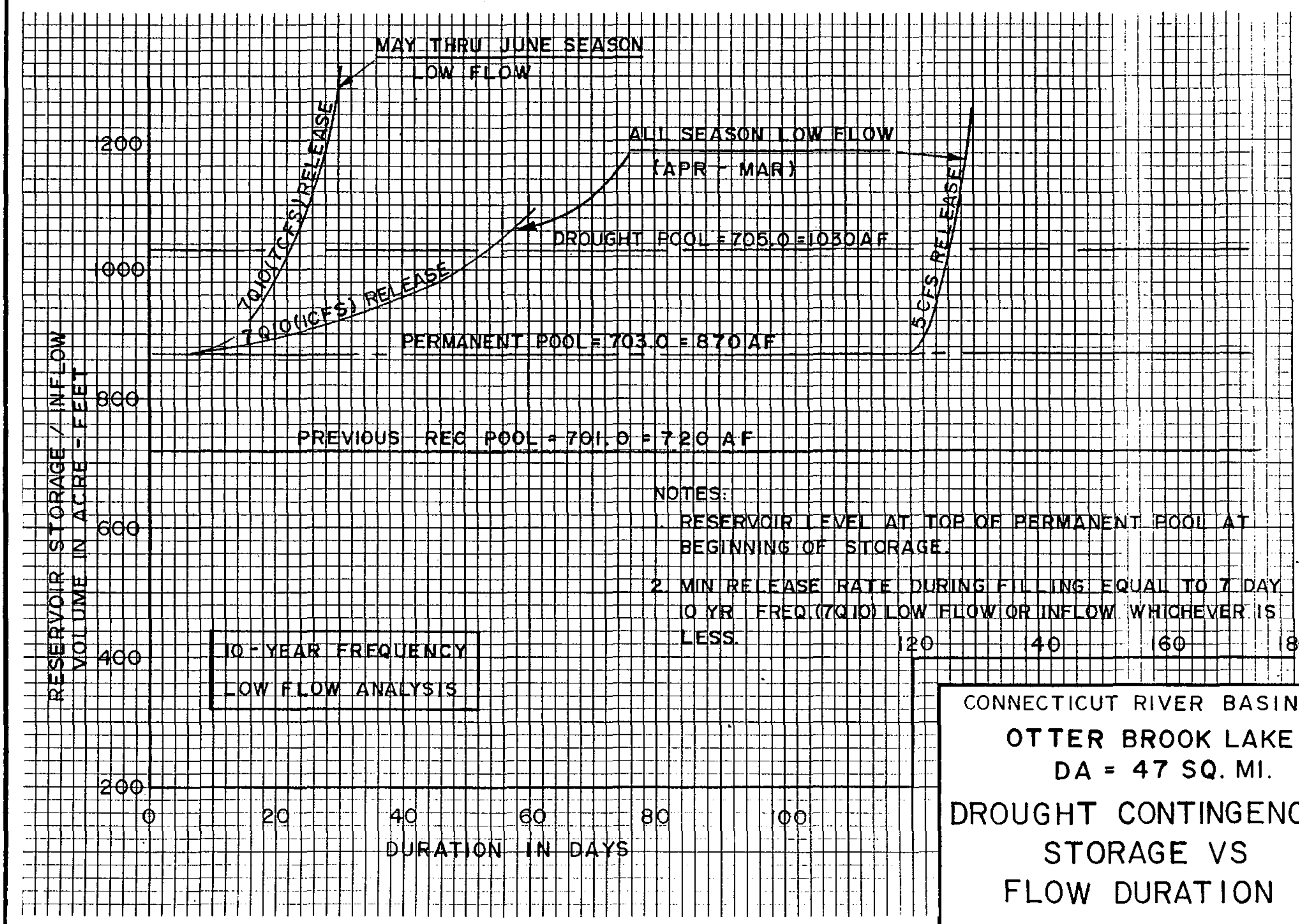
PLATE 1

OTTER BROOK RESERVOIR
AREA AND CAPACITY

DRAINAGE AREA = 47 S.M.

ELEV. FT.NGVD	STAGE FEET	AREA ACRES	CAPACITY AC. FT.	CAPACITY INCHES
683	0	11	40	.02
685	2	16	70	.03
687	4	22	110	.04
689	6	27	160	.06
691	8	32	210	.09
693	10	40	290	.11
695	12	47	370	.15
697	14	55	480	.19
699	16	62	590	.24
701	18	70	720	.29
701	18	70	0	0
703	20	76	150	.06
705	22	83	310	.12
707	24	90	480	.19
709	26	96	670	.26
711	28	103	870	.34
713	30	113	1080	.43
715	32	123	1320	.52
717	34	133	1580	.63
719	36	143	1850	.74
721	38	153	2150	.85
723	40	161	2460	.98
725	42	169	2790	1.11
727	44	177	3140	1.25
729	46	184	3500	1.39
731	48	192	3870	1.54
733	50	197	4260	1.70
735	52	203	4660	1.86
737	54	208	5070	2.02

ELEV. FT.NGVD	STAGE FEET	AREA ACRES	CAPACITY AC. FT.	CAPACITY INCHES
739	56	214	5500	2.19
741	58	219	5930	2.36
743	60	226	6370	2.54
745	62	232	6830	2.78
747	64	239	7300	2.91
749	66	245	7790	3.10
751	68	252	8280	3.30
753	70	259	8790	3.51
755	72	266	9280	3.71
757	74	273	9880	3.93
759	76	280	10480	4.15
761	78	288	10980	4.38
763	80	296	11580	4.61
765	82	303	12180	4.85
767	84	311	12780	5.09
769	86	319	13380	5.35
771	88	327	14080	5.57
773	90	336	14680	5.87
775	92	346	15380	6.14
777	94	355	16080	6.42
779	96	365	16780	6.70
781	98	374	17600	7.00
	Crest Elevation = 781			
783	100	383	18280	7.30
785	102	392	19080	7.61
787	104	400	19880	7.93
789	106	409	20680	8.25
791	108	418	21480	8.58
793	110	427	22380	8.92
795	112	435	23180	9.26
797	114	444	24080	9.61



CONNECTICUT RIVER BASIN

OTTER BROOK LAKE

DA = 47 SQ. MI.

DROUGHT CONTINGENCY

STORAGE VS

FLOW DURATION

PLATE 3

APPENDIX A

CLIMATOLOGIC AND HYDROLOGIC INDICATORS

APPENDIX A

DROUGHT CONTINGENCY PLAN
CLIMATOLOGIC AND HYDROLOGIC INDICATORS

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	a. General	A-1
	b. History	A-2
	c. Drought of Record	A-2
3	CLIMATOLOGIC AND HYDROLOGIC ANALYSIS	A-2
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	d. Palmer Drought Severity Index	A-11

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A-2	Rainfall and Runoff Guide Curves - Mass and Southern NH
A-3	Rainfall and Runoff Guide Curves - NH and Vt

DROUGHT CONTINGENCY PLAN
CLIMATOLOGIC AND HYDROLOGIC INDICATORS

1. INTRODUCTION

This appendix is presented to supplement the developed Drought Contingency Plan with climatological as well as hydrological data that are useful towards identifying and recognizing periods of dry or drought conditions. The analyses presented is not intended to predict a drought, as most drought predicting measures are not considered very accurate or promising. It is however, intended to aid in recognizing the onset of water shortage conditions in an effort to mitigate their impacts prior to severe or emergency conditions prevailing. It is most beneficial to recognize the beginning of a drought rather than to initiate action after the drought's effect become apparent.

The data presented is in the form of "guide curves" and do not serve the purpose of a single "trigger" in which emergency drought storage at Corps reservoirs would be initiated. As stated in the main text of the Drought Contingency Plan, NED's decision to store emergency water supply would be based on a combination of the guide curves as well as information received from various Federal and State agencies.

The data presented is an attempt to show regional indicators of dry or drought periods. While specific index stations were used in developing the guide curves, their use is not to be restricted to that station only. Their application is considered to represent generalized conditions in areas within the region.

Indicators such as rainfall-duration-frequency and minimum surface runoff-duration frequency were developed for various index stations within New England. Index stations selected were based on proximity to Corps drought contingency candidate reservoirs, period of record and reliability of data. The guide curves were developed and compared with historic drought data as a way to "track" current observed conditions with comparable historic conditions. Also presented is the Palmer Drought Severity Index (PDSI) classification chart with available New England historic drought index levels indicated.

2. DROUGHTS

a. General. Hydrologically, drought is defined as a prolonged period of precipitation deficiency which seriously affects riverflow as well as surface and groundwater supplies. The duration, magnitude, severity, frequency and areal extent have been identified as five common characteristics of drought. These characteristics are applicable to drought whether measured by precipitation, streamflow, reservoir levels or by the Palmer index.

b. History. Drought history in New England before 1900 is rather limited. Periods of precipitation deficiencies were experienced, however, records of runoff deficiency are relatively non-existent. Since the establishment of streamflow gaging stations, low flow periods and drought conditions have been observed throughout the New England river basins at various times. Serious droughts occurred within New England during the periods 1924-1927; 1929-1933 and 1961-1967.

c. Drought of Record. The drought of 1961 to 1967 was the longest and most severe in the history of the New England region. This was the severest in nearly 170 years of precipitation records in Boston, Massachusetts. The 1960's drought followed a period of above normal precipitation which contributed to relaxation on the part of cities and towns during what was really a period of rapidly increasing water demand. In addition, a considerable number of water facilities failed since most had been designed to meet a repetition of the less severe drought of the 1930's.

During the period 1963 through 1966, the cumulative precipitation deficiencies (i.e. total amount below normal) varied from about 40 to 60 inches throughout New England, which is equivalent to 1 to 1.3 years of normal rainfall.

The accumulative deficiency in the average runoff for water years 1962 to 1966 varied from about 25 to 50 inches throughout New England, equivalent to about 1 to 2 years of average annual runoff.

3. CLIMATOLOGIC AND HYDROLOGIC ANALYSIS

a. General. Streamflow, reservoir levels, ground water levels, soil moisture, precipitation and the Palmer Drought Severity Index are some of the indicators used by drought managers for early detection as well as continued tracking of a drought. This analysis focused on three of these indicators: rainfall; runoff and the Palmer Index. Rainfall and runoff were selected due to the large magnitude of available historic as well as current data. The Palmer Index was selected primarily due to its wide acceptance as a reliable drought indicator. While many more parameters are used in the drought identification process, it is believed that for purposes of the Drought Contingency Plans the parameters selected and the analysis performed offer a reasonable approach to drought management at NED reservoirs.

b. Climatological Data. Rainfall frequencies for 1, 3, 6 and 12 month durations were developed for various index stations. The curves were developed using the period of record monthly rainfall data at each index station. Accumulative tabulations were made for 1, 3, 6 and 12 consecutive months, assigning Weibull plotting positions and fitting the curves through the data. Index stations selected, with their corresponding periods of record, as well as the mean, maximum and minimum monthly rainfall, are shown in tables 1 through 3. The computed frequency curves are graphically shown on plates 1 through 3. Historic data, where available, was plotted on the 3, 6 and 12 month duration curves. The historic data was presented to allow comparison with any current data to that which occurred during historic droughts. This comparative analysis allows for a better understanding of the drought or dry period being experienced and provides for a historical perspective during drought tracking procedures.

Although the 1 and 3 month durations are presented, it is suggested that any drought emergency actions or conclusions not be based solely on the data of these short durations. In the New England region, experience has shown that low rainfall amounts for durations of 1 and 3 months do not necessarily constitute a dry or drought condition. For example: During the winter of 1988/1989 rainfall was historically low for a consecutive 3 month duration, measuring 6.5 inches at Storrs, Ct. Applying this rainfall to the 3 month curve identified the frequency to be about a 16 year drought, tracking somewhere between the historic droughts of 1924-1927 and 1980-1981. However, when the 6 month cumulative rainfall, during the same dry period, computed to be 21.5 inches, was applied to the 6 month curve, the frequency became less critical, equivalent to about a 2 year event. On an annual duration, the total 1989 rainfall amounts were considered at or above normal despite record low 3 month durations. Had drought emergency measures been implemented solely on the 3 month duration data it would have been proven to be premature or unnecessary. It is therefore recommended that although 1 and 3 month rainfall amounts should not be ignored, durations greater than 3 months should always be considered prior to any emergency drought plans being implemented.

c. Hydrologic Data. Streamflow data measured and published by the U.S. Geological Survey was used exclusively in all hydrologic analysis performed as part of this appendix. Since this analysis concerned itself with low streamflows, an attempt was made to identify and use streamflow index stations that are not regulated during periods of low flow. While many New England rivers and streams are regulated, to some extent, by mill pond dams, as well as other run of river type dams, it was assumed that any occasional regulation of low flows on the index stations selected would be considered to be minor and have minimal affect on natural low flow conditions. The mean, maximum and minimum monthly flows for four USGS gaging stations used as index stations in this report are presented in tables 4 through 7.

An annual low flow frequency analysis was made of the historical low flow data for each selected USGS gaging station. Low flows were determined for durations of 1, 3, 14, 30, 60, 90, 183 and 365 consecutive days for each climatological year (1 April

TABLE A-1

PRECIPITATION SUMMARY (INCHES)
STORRS, CONNECTICUT
ELEVATION 650 FT. NGVD
(101 Years of Record)

Month	Mean	Maximum	Minimum
January	3.65	13.79	0.64
February	3.25	7.89	0.37
March	3.94	10.65	0.15
April	3.80	10.94	0.55
May	3.76	9.21	0.33
June	3.33	12.79	0.29
July	4.15	12.15	0.78
August	4.19	14.75	0.47
September	3.84	17.00	0.45
October	3.64	8.82	0.15
November	4.00	9.24	0.47
December	3.84	9.97	0.68
ANNUAL	44.90	66.31	29.16

TABLE A-2

PRECIPITATION SUMMARY (INCHES)
AMHERST, MASSACHUSETTS
ELEVATION 150 FT. NGVD
(64 Years of Record)

Month	Mean	Maximum	Minimum
January	3.11	8.16	0.49
February	2.81	7.58	0.08
March	3.44	8.24	0.24
April	3.61	8.99	0.55
May	3.75	11.95	0.83
June	3.97	10.25	0.72
July	3.74	10.56	0.00
August	3.73	16.10	0.67
September	3.77	14.55	0.94
October	3.17	8.10	0.32
November	3.84	8.65	0.70
December	3.47	8.77	0.58
ANNUAL	42.55	60.25	29.55

TABLE A-3

PRECIPITATION SUMMARY (INCHES)
CONCORD, NEW HAMPSHIRE
ELEVATION 350 FT. NGVD
(69 Years of Record)

Month	Mean	Maximum	Minimum
January	2.69	8.09	0.40
February	2.45	7.77	0.03
March	3.12	10.36	0.55
April	3.11	6.63	0.42
May	3.10	9.52	0.60
June	3.34	10.10	0.64
July	3.38	7.57	0.96
August	3.01	6.88	0.95
September	3.16	10.68	0.41
October	2.85	8.78	0.05
November	3.73	7.59	0.50
December	4.56	10.34	0.58
ANNUAL	38.26	54.29	24.17

TABLE A-4

MONTHLY STREAM FLOW
QUINEBAUG RIVER AT JEWETT CITY, CT
DRAINAGE AREA = 713 Sq. Miles
(1919 - 1990)

Month	Mean		Maximum		Minimum	
	cfs	inches	cfs	inches	cfs	inches
January	1566	2.52	5694	9.18	219	0.35
February	1664	2.19	3919	5.16	473	0.62
March	2530	4.08	6930	11.17	1220	1.97
April	2436	3.68	5519	8.33	854	1.29
May	1534	2.47	2842	4.58	620	1.00
June	1033	1.56	4758	7.18	262	0.40
July	578	0.93	4110	6.63	138	0.22
August	498	0.80	3918	6.32	98	0.16
September	532	0.80	3502	5.28	97	0.15
October	630	1.02	3279	5.29	132	0.21
November	1066	1.61	3443	5.19	189	0.29
December	1434	2.31	4125	6.65	281	0.45
ANNUAL	1293	23.54	2015	38.24	598	11.35

TABLE A-5

MONTHLY STREAM FLOW
WEST BRANCH WESTFIELD RIVER
AT HUNTINGTON, MA
DRAINAGE AREA = 94 Sq. Miles
(1935 - 1990)

Month	Mean		Maximum		Minimum	
	cfs	inches	cfs	inches	cfs	inches
January	173	2.12	448	5.49	24	0.29
February	185	2.05	712	7.88	35	0.39
March	369	4.52	1098	13.46	112	1.37
April	503	5.97	1069	12.68	116	1.38
May	257	3.15	761	9.33	76	0.93
June	141	1.67	684	8.11	27	0.32
July	66	0.81	307	3.76	10	0.12
August	57	0.69	632	7.75	9	0.11
September	64	0.76	579	6.87	9	0.11
October	102	1.25	1041	12.76	13	0.16
November	173	2.05	544	6.45	25	0.30
December	195	2.39	664	8.14	40	0.49
ANNUAL	190	27.36	296	42.62	74	10.66

TABLE A-6

MONTHLY STREAM FLOW
SMITH RIVER NEAR BRISTOL, NH
DRAINAGE AREA = 86 Sq. Miles
(1918 - 1990)

Month	Mean		Maximum		Minimum	
	cfs	inches	cfs	inches	cfs	inches
January	99	1.33	253	3.39	19	0.25
February	99	1.20	578	7.00	21	0.25
March	254	3.41	1242	16.65	30	0.40
April	487	6.33	1077	14.00	183	2.38
May	230	3.08	504	6.76	72	0.97
June	104	1.35	353	4.59	21	0.27
July	52	0.70	387	5.19	9	0.12
August	34	0.46	168	2.25	5	0.07
September	41	0.53	457	5.94	8	0.10
October	68	0.91	267	3.58	9	0.12
November	127	1.65	379	4.93	25	0.33
December	131	1.76	393	5.27	22	0.29
ANNUAL	143	22.57	223	35.19	65	10.26

TABLE A-7

MONTHLY STREAM FLOW
WEST RIVER AT NEWFANE, VT
DRAINAGE AREA = 308 Sq. Miles
(1919 - 1990)

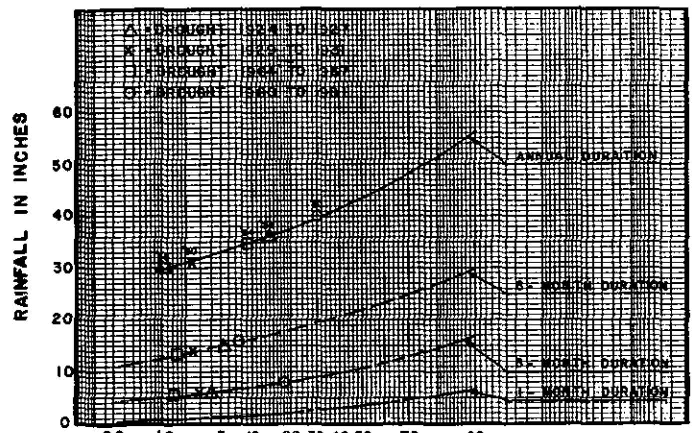
Month	Mean		Maximum		Minimum	
	cfs	inches	cfs	inches	cfs	inches
January	452	1.69	1515	5.67	95	0.36
February	444	1.50	1497	5.06	109	0.37
March	1090	4.08	3712	13.89	184	0.69
April	2199	7.92	4411	15.88	589	2.12
May	1010	3.78	2733	10.23	249	0.93
June	403	1.45	1439	5.18	64	0.23
July	205	0.77	1321	4.94	29	0.11
August	159	0.60	1539	5.76	36	0.13
September	200	0.72	1667	6.00	22	0.08
October	337	1.26	1768	6.61	33	0.12
November	567	2.04	1437	5.17	91	0.33
December	556	2.08	1578	5.91	137	0.51
ANNUAL	636	28.02	1084	47.77	272	11.98

to 31 March) using the USGS "WATSTORE" data storage and retrieval computer system. The annual low flows for each duration were fitted to a Log Pearson Type III distribution. The fitting technique involves transforming annual low flow values to logarithmic values and finding the mean, standard deviation and skew coefficient of the logarithms. The computed low flow frequency duration curves are shown graphically on plates 1 through 3. Historical data, where available, was plotted for each index station. It is noted that low flow duration curves are not shown less than a 30 day period. Within New England, low streamflow data, over a consecutive period of less than 30 days, is considered to be inconclusive when assessing drought conditions.

d. <u>Palmer Drought Severity Index (PDSI).</u> The Palmer Drought Severity Index is a widely used indicator of drought conditions. It is published in the following: "Weekly Weather and Crop Bulletin" prepared jointly by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of Agriculture (USDA); "Weekly Climate Bulletin" of the NOAA, Climate Analysis Center; and monthly "National Water Conditions" report of the U.S. Geological Survey. The National Climate Center computes the PDSI for all climate divisions in the contiguous United States.

The PDSI is a meteorological index that reflects estimates of departure of soil moisture from normal. Normal moisture conditions are derived from period of record data including monthly averages of evapotranspiration, soil water recharge, runoff and water loss from the soil. The index is standardized so that it has a consistent meaning in different climate areas and from month to month. The classification system translates the numerical value of the index to a descriptive measure of drought or wetness. The dry periods on the index are classified as extreme drought and assigned a numerical value of -4.0. The region on the PDSI graph between extreme drought and near normal conditions was subdivided into three additional drought categories: Severe (PDSI = -3.0): Moderate (PDSI = -2.0); and Mild (PDSI = -1.0). The current PDSI classification system is shown graphically on plates 1 through 3. Also shown on the PDSI graphs are the classifications assigned by others to some historic droughts data that occurred throughout New England.

The PDSI is presented as a tool in assessing current wet or dry conditions only and should be used in conjunction with other hydrological and climatological data for effective drought management. The PDSI should not be used for drought planning or hydrologic drought forecasting.

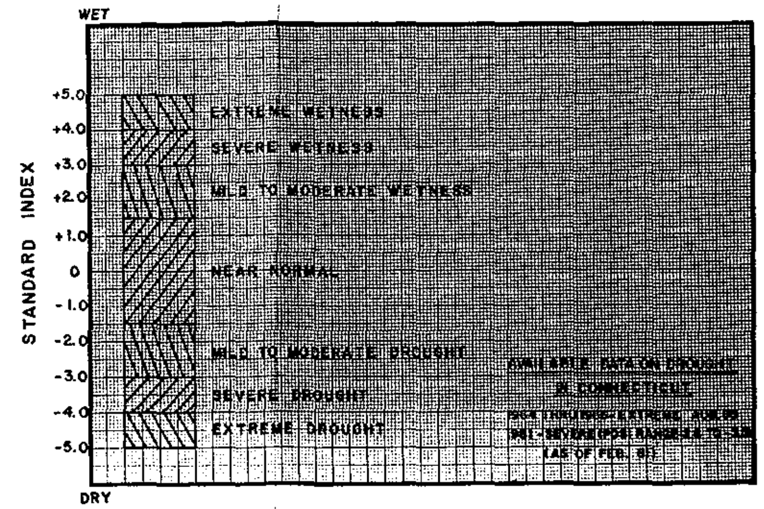


PERCENT CHANCE OF OCCURENCE IN ANY YEAR

RAINFALL DURATION CURVES

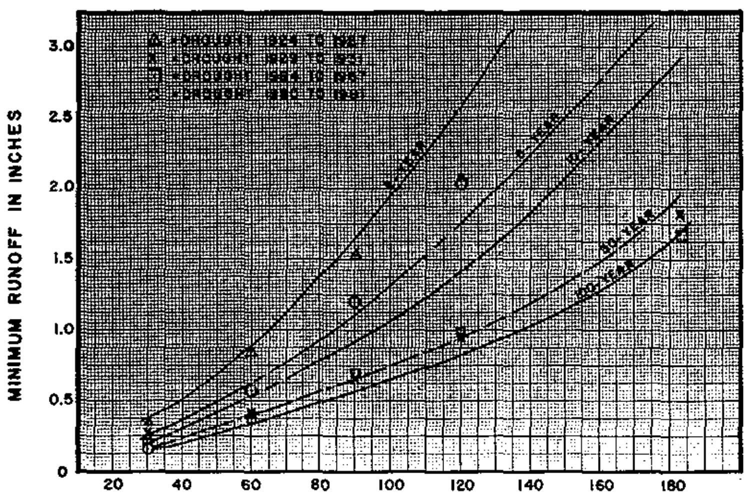
STORRS, CONNECTICUT (EL.= 650.0 FT. N.G.V.D.)

PERIOD OF RECORD 101 YRS.



PALMER DROUGHT SEVERITY INDEX (PDSI)

STANDARD CLASSIFICATION INDEX OF WET AND DRY PERIODS



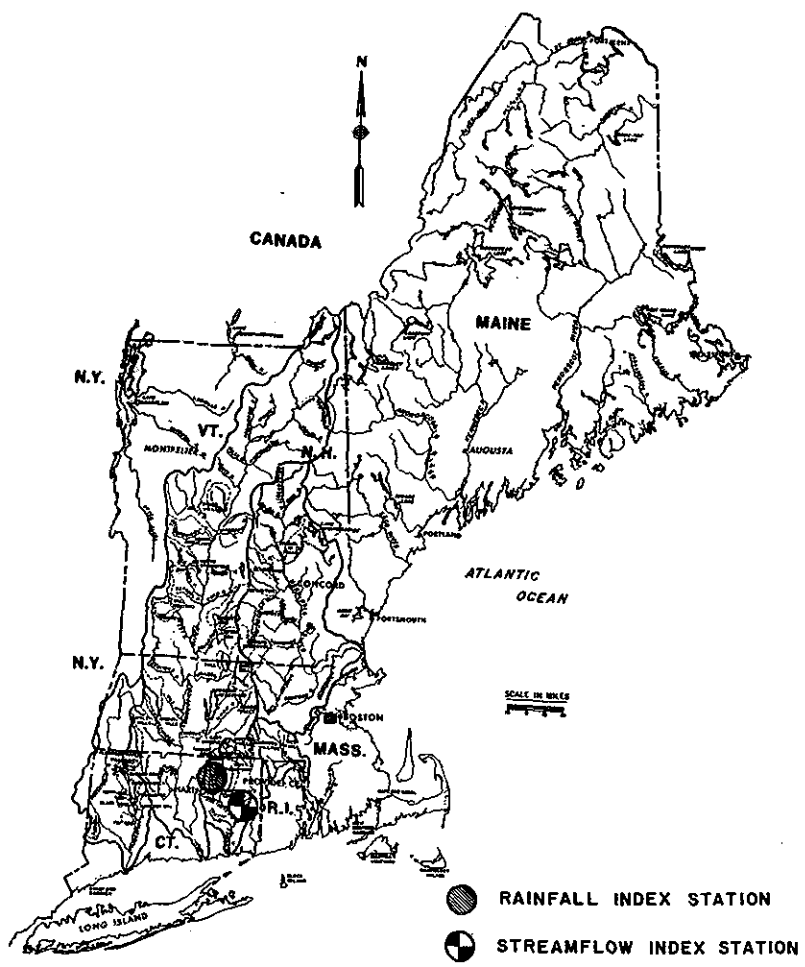
DURATION IN DAYS

MINIMUM RUNOFF-FREQUENCY CURVES

QUINEBAUG RIVER AT JEWETT CITY, CONNECTICUT

D.A. = 713 SQ. MI.

PERIOD OF RECORD 73 YRS.



RAINFALL AND STREAMFLOW LOCATION MAP

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

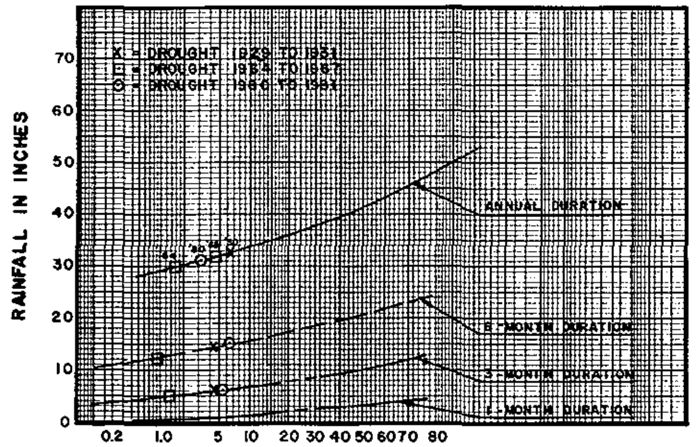
DROUGHT CONTINGENCY PLAN

RAINFALL AND RUNOFF

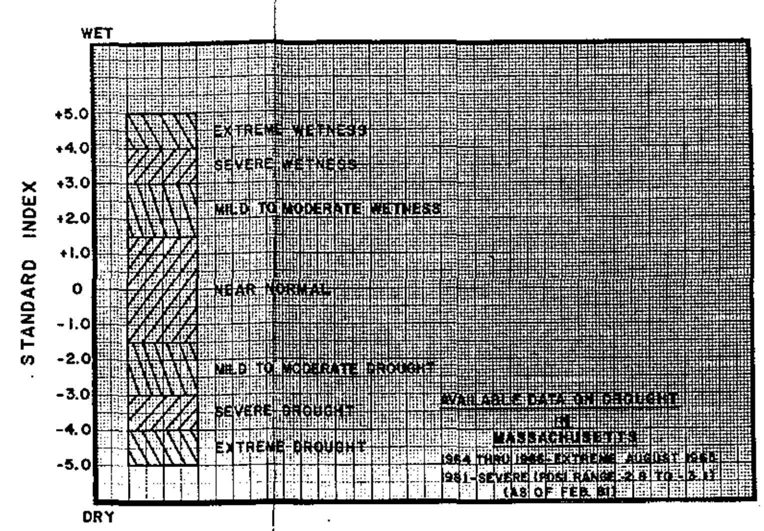
GUIDE CURVES FOR

SOUTHERN NEW ENGLAND

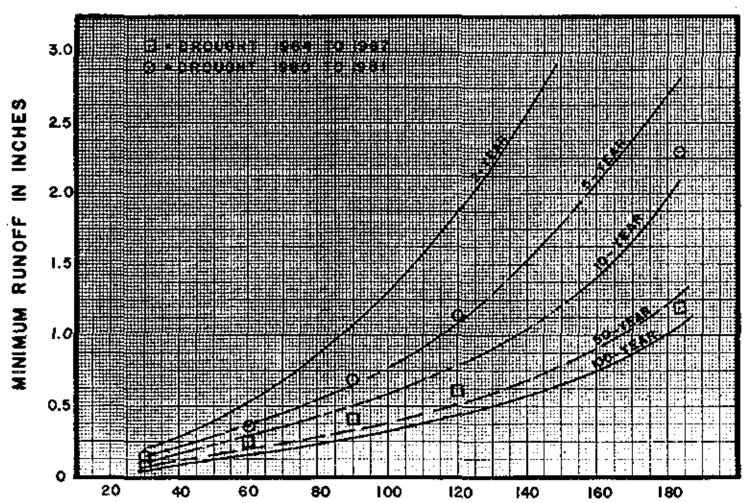
PLATE A1



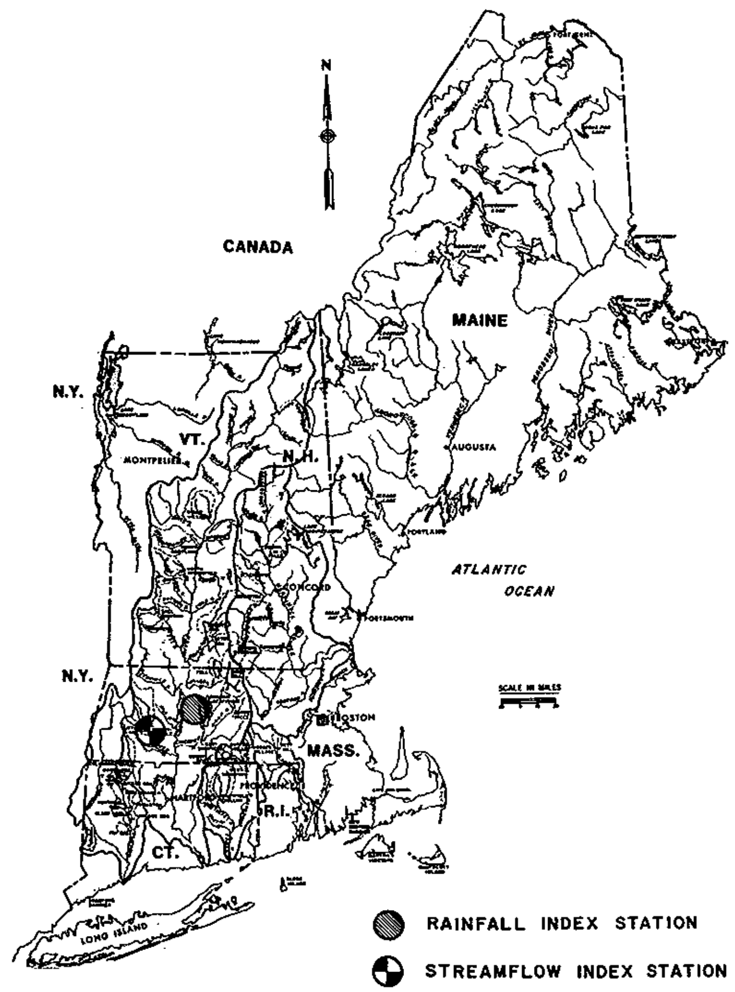
RAINFALL DURATION CURVES
AMHERST, MASSACHUSETTS (EL.= 150.0 FT. N.G.V.D.)
PERIOD OF RECORD 64 YRS.



PALMER DROUGHT SEVERITY INDEX (PDSI)
STANDARD CLASSIFICATION INDEX OF WET AND DRY PERIODS



MINIMUM RUNOFF-FREQUENCY CURVES
WEST BRANCH WESTFIELD RIVER AT
HUNTINGTON, MASSACHUSETTS
D.A. = 94 SQ. MI.
PERIOD OF RECORD 54 YRS.



RAINFALL AND STREAMFLOW LOCATION MAP

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

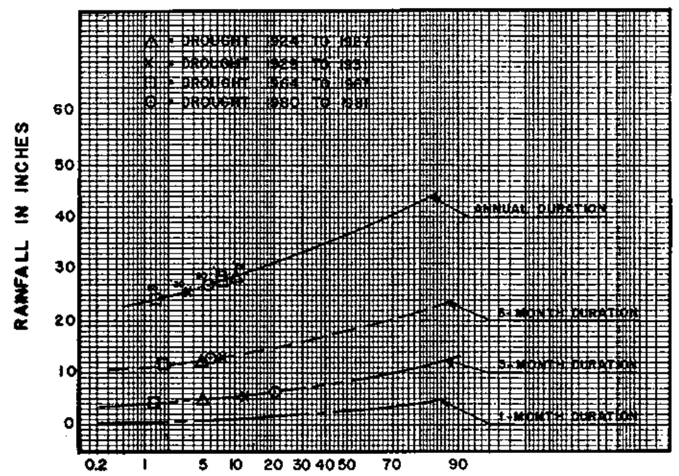
DROUGHT CONTINGENCY PLAN

RAINFALL AND RUNOFF

GUIDE CURVES FOR

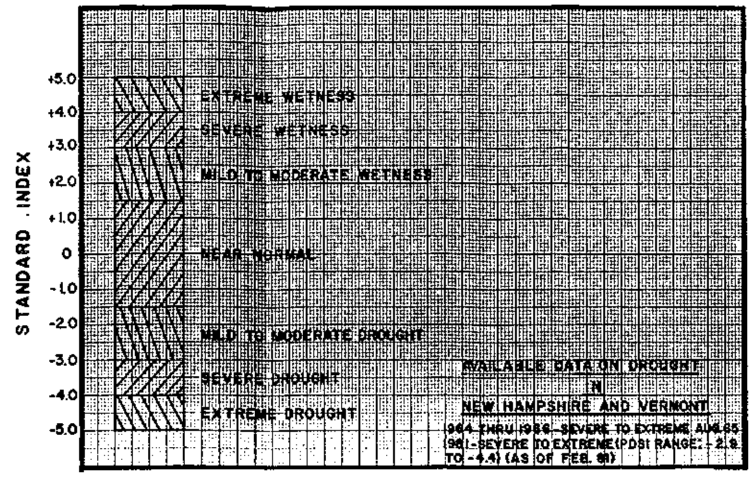
MASSACHUSETTS AND SOUTHERN N.H.

PLATE A2



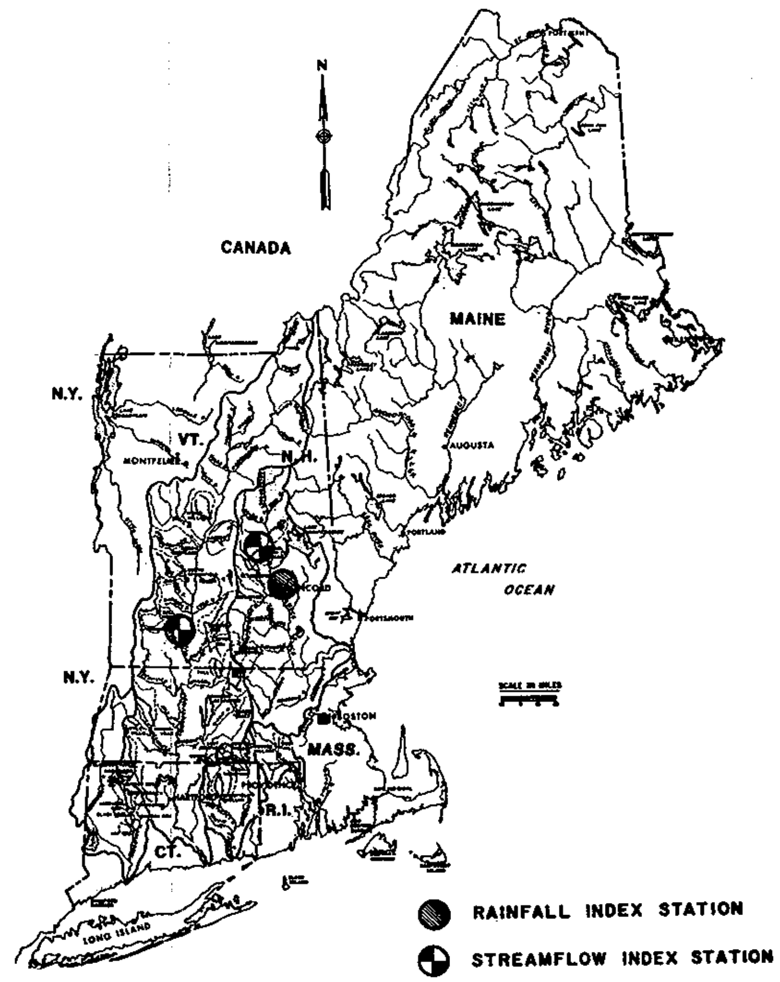
RAINFALL DURATION CURVES

CONCORD, NEW HAMPSHIRE (EL. = 350.0 FT. N.G.V.D.)
PERIOD OF RECORD 69 YRS.

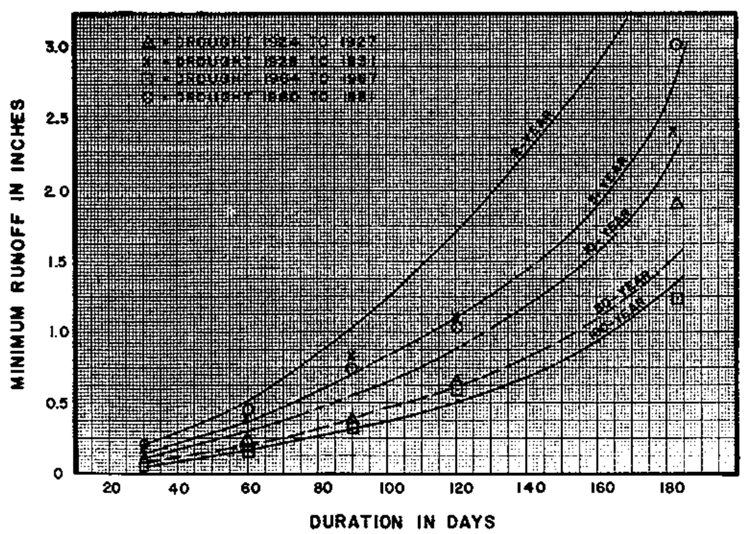


PALMER DROUGHT SEVERITY INDEX (PDSI)

STANDARD CLASSIFICATION INDEX OF WET AND DRY PERIODS

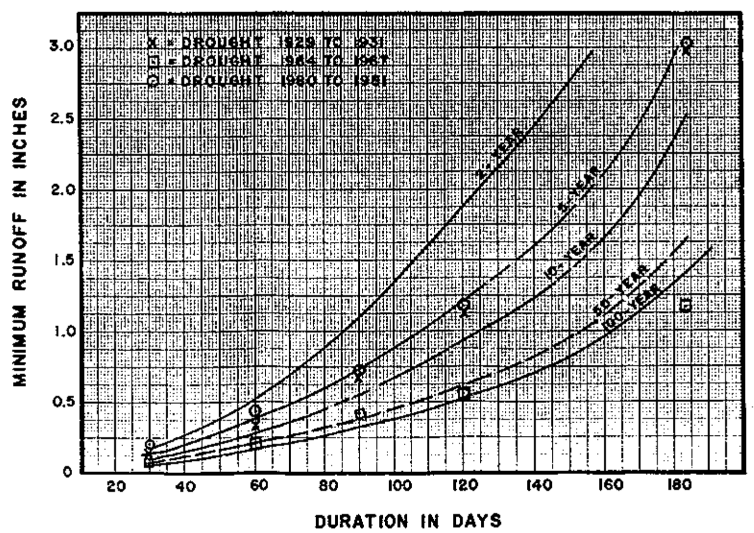


RAINFALL AND STREAMFLOW LOCATION MAP



MINIMUM RUNOFF-FREQUENCY CURVES

SMITH RIVER NEAR BRISTOL NEW HAMPSHIRE
D.A. = 85.8 SQ. MI.
PERIOD OF RECORD 71 YRS.



MINIMUM RUNOFF FREQUENCY CURVES

WEST RIVER AT NEWFANE, VERMONT
D.A. = 308 SQ. MI.
PERIOD OF RECORD 63 YRS.

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DROUGHT CONTINGENCY PLAN

RAINFALL AND RUNOFF

GUIDE CURVES FOR

NEW HAMPSHIRE AND VERMONT

APPENDIX B

ECONOMIC ASSESSMENT

ECONOMIC ASSESSMENT OF
DROUGHT CONTINGENCY WATER SUPPLY PRICING
at OTTER BROOK LAKE RESERVOIR

APPENDIX B

PREPARED BY:
ECONOMIC AND RESOURCE ANALYSIS BRANCH
IMPACT ANALYSIS DIVISION
PLANNING DIRECTORATE

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

JULY 1991

ECONOMIC ASSESSMENT OF DROUGHT CONTINGENCY WATER SUPPLY PRICING AT OTTER BROOK LAKE RESERVOIR

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INTRODUCTION

The purpose of this report is to develop a methodology to be used to develop a price for drought contingency water supply. The methodology is developed in accordance with ER 1105-2-100, Chapter 4, Section 7 with the exception of including updated construction cost as an element of the price to be charged to the non-federal user.

METHODOLOGY

The amount to be charged for drought contingency water is determined by finding the appropriate share of joint cost attributed to drought contingency water supply, obtaining all cost that can be attributed to the provision of drought contingency water, and accounting for any benefits forgone from the existing project due to the provision of drought contingency water.

The joint cost of providing water is determined by deducting specific cost from total operation, maintenance, replacement and major rehabilitation. The non-federal share of joint cost applied to drought contingency is determined by dividing the volume in acre-feet devoted to drought contingency water supply by the total usable storage space in acre-feet. This ratio is then multiplied by annual joint use cost to determine the non-federal share.

To the joint use annual cost is added any separable cost that is due entirely to the drought contingency water supply function. Reductions in project benefits are then calculated (if any) and added to the non-federal share.

The price will be determined on an annual basis and updated for each year of the drought contingency water supply contract with the non-federal user.

WATER SUPPLY PRICE

The development of a price to be charged the non-federal user is shown in Table 1.

Joint Use Cost

Joint Use Cost is project cost that cannot be separated by type of project benefit. This cost is obtained by deducting from total O & M cost (Column 3) that is specific to recreation (Column 4). The result is shown in Column 5. The share that is attributed to water supply is obtained by dividing acre-feet available for drought contingency water supply (Column 1) by total acre-feet of available storage (Column 2). This factor is then multiplied by joint use O&M (Column 5) and Rehabilitation and Replacement (Column 6) to determine that portion of joint cost that is to be allocated to drought contingency water supply. The result is shown in columns 9 and 10.

Table 1
Drought Contingency
Water Supply Pricing
1991 Price Level

RESERVOIR	WS-VOL (AC-FT)	TOT-VOL (AC-FT)	TOT O&M (000)	REC O&M (000)	JT O&M (000)	JT REHAB (000)	SEP WS (000)	LOST REC (000)	JT O&M-WS (000)	REHAB-WS (000)	WS-ANN'L	WS-DAIL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
OTTER BROOK	160	17,600	356.3	67.4	288.9	10	2.2	20.3	2.6	0.1	$22,914.	$409.18
No change in usage								5.1			$ 7,714.	$137.75
recreation excluded								0			$ 2,614.	$ 46.68

Separable Cost

Otter Brook Lake was the only reservoir in the study where separable cost could be identified for the drought contingency water supply function. Separable cost identified as being the result of providing drought contingency water supply is additional beach cleanings, movement of buoys in the swimming area and replacement of turf in back of the beach. This cost is estimated to be $2,200. The derivation of cost is shown in Table 2. Cost data was supplied by Jack Boyea, the Otter Brook Lake Project Manager.

Table 2
Otter Brook Lake
Drought Contingency Cost

Drought Contingency Period	8 weeks (July and August)
Beach Clean-up	2 hours per week
Moving Buoys	32 hours
Turf Replacement	$1,000
Labor Rate	$25.72 per hour (GS-9, Step 1)
Cost	
Labor	
Beach Clean-up	$400
Moving Buoys	$800
Total	$1,200
Materials	$1,000
Total	$2,200

Benefits Foregone

Recreation opportunities available at Otter Brook Lake include swimming, boating and picnicking. Raising the pool to elevation 705 feet NGVD will have an effect on recreation. Approximately one-half the beach will be inundated during the months of July and August reducing the amount of dry beach area available to bathers. Recreation value will be lost as some bathers will be excluded on weekends and crowding will become more severe both on weekends and weekdays. The lost recreation value is estimated to be $20,300 annually. The data used to determine recreation value is displayed in Table 3. Information on beach usage and area was supplied by Jack Boyea.

Table 3
Otter Brook Lake
Beach Recreation Data

	Existing Pool (Elevation 703 NGVD)	Drought Contingency Pool (Elevation 705 NGVD)
Beach Area (SF)	12,000	6,000
Beach Usage		
Weekends	1,250	938
Weekdays	275	275
Turnover Rate	2.4	2.4
Beach Area Per Person (SF/PERSON)		
Weekends	23	15
Weekdays	105	52
Beach Days		
Weekends	13	13
Weekdays	29	29
Beach Day Value (Per Person Per Day)		
Weekends	$3.84	$3.74
Weekdays	$4.43	$3.99
Recreation Value		
Weekends	$62,400	$45,600
Weekdays	$35,300	$31,800
Total	$97,700	$77,400

Recreation value per visit is determined using a rating system provided in ER 1105-2-100. The beach is rated under existing conditions and with a drought contingency pool. Rating criteria are shown in Table 4. The scale for conversion of points into dollars is described in Economic Guidance Memorandum 91-2. Recreation value is the product of the number of beach users per day, the number of beach days and the value per person per day. Recreation value declines with the drought contingency pool as a reduction in beach space reduces the number of people that can use the beach on a weekend and increases overcrowding on both weekends and weekdays which reduces the value of a beach day. It is estimated that recreation value will decline by $20,300 annually with the drought contingency pool. This result is shown in the bottom of Table 3.

Table 4
Otter Brook Lake
Rating and Value
1991 Price Level

	Otter Brook Recreation Rating Existing Conditions Weekends	Weekdays	With DC Pool (EL. 705) Weekends	Weekdays
1. Recreation Experience	4	4	4	4
2. Availability of Opportunity	8	8	8	8
3. Carrying Capacity	3	11	1	5
4. Accessibility	12	12	12	12
5. Environmental Quality	13	13	13	13
TOTAL	40	48	38	42
USER DAY VALE	3.84	4.43	3.74	3.99

SENSITIVITY ANALYSIS

There is uncertainty with respect to the impact of beach reduction on beach use. The analysis anticipates about a 25 percent decline in attendance from 1,250 to 938 on weekends. There is no anticipated decrease in beach attendance during the week. To the immediate rear of the beach is a grassy area that may be utilized by beach goers. If beach goers find this area to be a reasonable substitute for dry beach space then there may not be a decline in use as a result of providing a drought contingency pool. Although beach usage would not decline there would be some overcrowding on existing dry beach space and the grass would be somewhat less desirable to most beach goers resulting in a decline in recreation value per visit. Utilizing the information in Tables 3 and 4, and keeping attendance constant with the drought contingency pool, recreation value would decline by $5,100 annually.

SUMMARY

The price of water should be equal to the cost of providing the water. This cost has two components - the New England Divisions direct cost of providing the water and the foregone recreation as a by-product of this process.

The daily price to be charged for drought contingency water supply (Table 1, Column 12) is obtained by adding water supply's share of joint O&M and major rehabilitation and replacement cost (Cols. 9 and 10) and dividing by 365. To this is added separable water supply cost and foregone recreation value. These latter two magnitudes are put on a daily basis by dividing by 56 days which is the period that drought contingency water supply would be available. Annual cost shown in Col. 11 is obtained by multiplying col. 12 by 56.

There are three separate prices shown in Table 1 for provision of drought contingency water. The first two reflect the uncertainty in anticipated recreation utilization with a drought contingency pool, while the third price represents the direct cost incurred by NED only. Thus the price of water per day, based on total cost, will range from $137.75 to $409.18 or $7,714 to $22,914 annually based on a 56 day season. The price of water based on NED cost is only $46.68 per day or $2,614 annually.

NED will charge the State of New Hampshire only the Corps' direct cost of providing the drought contingency pool. This procedure is appropriate as the citizens of New Hampshire comprise the majority of Otter Brook beach users as well as being potential users of the drought contingency water. This method will allow the State of New Hampshire to choose the trade off between water based recreation and drought contingency water that it deems appropriate. This trade off will be made at a price that reflects economic cost which includes lost recreation as well as NED's direct cost of providing the drought contingency water. The payment made to NED however, will only cover NED's direct cost.

Drought contingency water supply price should be established for a period of one year and updated in successive years based upon changes in O&M, major rehabilitation and replacement and recreation value.

APPENDIX C

WATER QUALITY EVALUATION

APPENDIX C

WATER QUALITY EVALUATION
OTTER BROOK LAKE DROUGHT CONTINGENCY STUDY
KEENE, NEW HAMPSHIRE

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APPENDIX C

WATER QUALITY EVALUATION
OTTER BROOK LAKE DROUGHT CONTINGENCY STUDY
KEENE, NEW HAMPSHIRE

1. SUMMARY

Drought contingency storage at Otter Brook Lake would raise the pool 2.0 feet above elevation 703.0 to 705.0 feet NGVD, from a maximum depth of 20.0 to 22.0 feet. This increase would only occur during a declared drought period. Water quality effects that could result from drought storage include decreases in dissolved oxygen, and increases in water temperature, iron, manganese, phosphorus, ammonia, color, and suspended solids. These increases would be minor and are not expected to threaten aquatic life or human health. Although the lake would be subject to a greater potential for the occurrence of localized algae blooms, severe algae problems are not anticipated and trophic status of the lake should remain unchanged. Effects of drought storage operations on downstream water quality are expected to be minimal as well. The waters of Otter Brook Lake would require standard treatment processes for drinking water supply, but no treatment would be necessary for fire-fighting, irrigation, and most industrial uses in the event of drought storage implementation.

2. WATER QUALITY CLASSIFICATION

Otter Brook and its tributaries above Otter Brook Lake are rated class B by the New Hampshire Water Supply and Pollution Control Commission. Class B waters have high aesthetic value with no objectionable physical characteristics. These waters are acceptable for primary and secondary recreation and, after adequate treatment, for use as water supplies. Otter Brook Lake and its tributaries are further designated as warm water fisheries, and have cold water put and take fishery management during spring.

Technical requirements for class B waters include a minimum dissolved oxygen concentration of 6 mg/l, no fecal coliform bacteria in excess of an arithmetic mean of 240 organisms per 100 ml sample, pH in the range of 6.5 to 8.0 except when due to natural conditions, and a maximum turbidity level of 10 JTU's. These standards further prohibit color, solids, slicks, temperature rise, pH, phosphorus, taste or odor except as naturally occurs; and potentially toxic substances in toxic concentrations or combinations.

3. EXISTING WATER QUALITY CONDITIONS

a. General. Relatively few sources of pollution contribute to the Otter Brook Lake watershed, consequently, the waters are of high quality. Furthermore, the lake is borderline oligotrophic/mesotrophic with low mean hydraulic detention times, weak to moderate thermal stratification patterns and no significant algae problems.

b. Watershed Land Use. Drainage area at Otter Brook Lake includes 47 square miles of which only 3 are drained by Ferry Brook and the remaining 44 are drained by Otter Brook.

Otter Brook Lake watershed is rural with relatively little residential and agricultural, and no industrial development. The terrain is hilly and heavily wooded, with some wetlands and fields. The 375-acre reservoir area is primarily used for flood control, but also for boating, swimming, fishing, forestry resources, and fish and wildlife management.

According to the State of New Hampshire Water Supply and Pollution Control Commission, no known point source discharges from industries or municipalities empty into rivers upstream from Otter Brook Lake. Also, since heavy residential and agricultural development are not prevalent in the drainage basin, the rivers are not usually subject to non-point source discharges due to runoff events.

c. Water Quality Conditions. The waters of Otter Brook Lake are of high quality, usually meeting or exceeding New Hampshire class B requirements. Water quality data collected at inflow and discharge stations through the NED sampling program since 1971 show consistently high dissolved oxygen and low turbidity levels. In addition, fecal coliform and dissolved solids levels almost always meet state standards. Minor areas of concern include low pH, and high color, iron and manganese levels in these waters. Nutrients levels are low to moderate at inflow and discharge stations. Although nitrate and nitrite measurements occasionally exceed threshold concentrations capable of supporting algae blooms in an impoundment, phosphorus exceedances are very rare. Nuisance algae blooms have never been observed in Otter Brook Lake, probably due to the low levels of nutrients found in these waters.

Mean pH levels usually fall short of the recommended 6.5 to 8.0 range, and the waters are somewhat acidic. Low pH may be attributed to runoff from acid precipitation on poorly buffered New Hampshire soil and natural conditions in the watershed. High color, iron, and manganese levels are common in the waters of Otter Brook Lake, frequently exceeding drinking water supply limits established by the EPA. These limits are set for aesthetic purposes and to prevent taste and laundry staining problems. Present concentrations of color, iron and manganese are not health hazards to humans or aquatic life. High color, iron and manganese levels found in these waters most likely originate from natural sources in the watershed.

d. <u>Reservoir Conditions</u>. At 703.0 feet NGVD the pool volume is 870 acre-feet covering a surface area of about 76 acres to a maximum depth of 20.0 feet. Mean hydraulic residence times of 16, 20, and 19 days were calculated for July, August, and September, respectively. These are based on average monthly Otter Brook flows measured by the US Geological Survey for the period of record (1958 to 1990) at the gaging station near Keene, NH, located 450 feet downstream from the dam.

Water temperatures in the lake and its tributaries provide good habitat for warm water fish species. These waters also provide a satisfactory cold water fish habitat until early summer when temperatures usually exceed 70° Fahrenheit ($^{\circ}$F). Sections of Otter Brook and upper parts of the lake are stocked with trout in the spring by the NH Fish and Game Department.

Lake profiling data were collected in 1974, 1975, 1977, 1978, and 1982 at this project and incorporated in the April 1983 "Otter Brook Lake Water Quality Evaluation" produced by NED. According to this study, Otter Brook Lake exhibits weak to moderate thermally-induced density stratification patterns which form, break up, and reform during the summer. The largest surface-to-bottom temperature difference of the five years profiled was 38°F recorded in late June of 1978. Although fairly large surface-to-bottom temperature differences occur in the summer, the lake is not always clearly divided into a strong epilimnion, thermocline and hypolimnion of classical stratification. Results of this study also indicate that warmer summer inflows travel along the top of the lake and discharge over the weir without mixing with the deeper waters of the impoundment. Although dissolved oxygen (DO) measurements are high at inflow and discharge stations, DO decreases significantly from the surface to bottom waters showing low to anaerobic levels in the deepest parts of the lake. High DO levels in the epilimnion and anaerobic conditions in the hypolimnion are common from June through September. In addition, pH levels generally tend to decrease with depth as well. Finally, phosphorus and ammonia levels increase near the bottom of the lake, especially where the waters are anaerobic.

Based on the fairly warm water temperatures, low to moderate levels of nutrients, low hydraulic residence times and the absence of nuisance algae blooms, Otter Brook Lake most closely resembles a borderline oligotrophic/mesotrophic waterbody. A lake of this trophic status will rarely experience major algae blooms; however, occasional local blooms would be expected especially during summer when low flows increase the hydraulic residence time.

4. WATER QUALITY REQUIREMENTS OF DROUGHT STORAGE

Two water quality requirements must be achieved for municipal storage. The waters must meet State and Federal standards for surface waters and must be of a quality suitable for the water supply user. A water which meets class B standards in New Hampshire is usable for drinking water supply if standard treatment processes are used. Water quality requirements for industrial water supply depend on the industrial process involved.

Compatibility of contact recreation with water supply storage should be considered since swimming is currently allowed in Otter Brook Lake. With water supply withdrawal from Otter Brook likely to occur some distance downstream from the dam, it is not expected that bacteriological contamination originating through the recreational use of the lake will normally be a problem. However, recreational pressure is expected to be greatest during warm drought months when water supply would be needed. In coordination with the Corps of Engineers, the State of New Hampshire should determine whether continued primary contact recreation should be allowed at the lake during drought storage periods.

The city of Keene and state of New Hampshire are potential water supply users of drought storage at Otter Brook Lake. At normal recreation pool capacity, the water is suitable for municipal and industrial water supply following the use of conventional treatment processes. In addition, these waters would be suitable for fire-fighting or irrigation without treatment.

5. EFFECTS OF INCREASED STORAGE ON NORMAL RESERVOIR WATER QUALITY

Drought contingency storage at Otter Brook Lake would increase the pool 2.0 feet from a pool level of 703 feet NGVD to a water surface elevation of 705 feet NGVD (maximum depth of 22.0 feet) from July to November. This increase would only occur during a declared drought period, changing the lake's volume from 870 to 1,030 acre-feet and surface area from 76 to 83 acres. Since very little water quality data during drought is available, the following discussion describes expected water quality changes due to additional storage based on normal flows at the project. Quality of water in the enlarged impoundment may degrade slightly due to the effects of newly inundated acreage, a deeper pool, and longer hydraulic residence times, but these changes would be fairly minor.

Inundation of vegetated lands when the pool is raised will affect water quality by causing a decay of organic material thereby releasing nutrients and metals to the overlying waters. This could lead to increases in color and suspended sediments, and, because of additional nutrients, a greater susceptibility to localized algae blooms. Raising the pool may also cause sloughing of embankments from wave action and during drawdown events. Most of the eroded soil would settle in the lake, but some would discharge downstream. Increased color, erosion and sedimentation will not affect the suitability of the water for water supply or recreation, but may degrade the aesthetics of the area. This degradation would be minor since the increase in lake volume (18.4 percent) would dampen the effects of increased color, sedimentation and erosion caused by a relatively small increase in newly inundated acreage (9.2 percent).

Increased pool volume and depth may slightly strengthen stratification patterns at Otter Brook Lake, increasing the extent and duration of anaerobic conditions. Since stratification patterns are presently weak to moderate, a strong hypolimnion probably would not persist, but would continue to form, break apart and reform throughout summer. Sediments in areas devoid of oxygen become chemically reduced causing iron, manganese, ammonia and phosphorus to become soluble and diffuse into the overlying waters. Ammonia also tends to increase under reduced dissolved oxygen conditions due to the reduction of nitrite and nitrate present in the water. Increases in the above constituents promote the potential for algae problems.

Enlarging the pool will also increase mean hydraulic residence times by 3 or 4 days to 19, 24, and 23 days for July, August, and September, respectively. Longer hydraulic residence times reduce flushing of the system which promotes warming of the waters. Warmer waters will strengthen thermal stratification patterns further increasing the amount and duration of anaerobic conditions in the lake's deepest waters. Again, an anaerobic environment can cause increases in iron, manganese, ammonia and phosphorus in the waters of Otter Brook Lake. Warmer water may slightly degrade cold water fish habitat in the impoundment and downstream from the dam. Higher temperatures and nutrients concentrations can also cause algae problems, although, these are expected to be localized and nuisance blooms across the lake are not anticipated. However, since mean detention times of the proposed impoundment would only increase by about a week, water quality effects should be minimal with little change to the trophic status.

6. EFFECTS OF REDUCED FLOWS ON WATER QUALITY DURING DROUGHT

Drought storage is proposed at Otter Brook Lake to supply additional water to downstream municipalities or industries in the event of a drought emergency. Drought storage would begin mid-spring, generally reaching the required 705 feet NGVD by July. The following paragraphs discuss how normal water quality could change as a result of reduced flows at the project during droughts.

Droughts or long periods of low flow can have a pronounced effect on water quality. Reduced flows in streams are undesirable because stream temperatures tend to increase due to reduced depths and velocities, and dissolved oxygen levels tend to drop due to increased temperatures and reduced assimilative capacities. On the other hand, in the absence of industrial or municipal discharges into Otter Brook Lake's watershed, the principal source of fecal coliform, nitrates and nitrites is runoff. The decreased runoff during droughts will result in lower levels of these parameters. Overall, however, the undesirable effects of droughts outweigh any improvements in some water quality parameters.

In addition to the degraded water quality of its tributaries during droughts, decreased flows at Otter Brook Lake will cause hydraulic detention times to increase significantly. Based on minimum monthly Otter Brook flows for the period of record (1958-1990) at the gaging station near Keene, NH, maximum hydraulic detention times in the proposed drought storage pool for July, August, and September would be 190, 235, and 675 days, respectively. With these detention times, the lake would become virtually stagnant and associated water quality degradation caused by increased temperatures and more extreme stratification patterns can be expected.

Effects of drought on water quality, however, will occur regardless of the increase in pool size to accommodate drought storage. Maximum hydraulic detention times for the recreation pool alone during July, August, and September were estimated to be about 160, 200, and 570 days, respectively. At these levels, the lake will also experience almost complete stagnation and significant water quality degradation. Since maximum detention times for the proposed drought storage pool are not that much longer than those for the recreation pool alone, water quality degradation would be similar in nature, but somewhat more severe.

At Otter Brook Lake, the recreation pool level is normally controlled by a weir which draws water from the lake's surface and inhibits oxygenation of water at the bottom, especially during low flow periods. To enhance downstream water quality and reduce stagnation at the bottom of the pool, partial gate releases are made throughout summer on warm days and during low flow periods. These low level releases are cooler than and mix with the warm surface waters flowing over the weir to provide a better downstream aquatic habitat. Dissolved oxygen concentrations meet the technical requirements for class B waters due to the turbulence encountered within the outlet works. Making small releases through the gates during drought periods would help to improve pool and downstream water quality.

7. EFFECTS OF DROUGHT STORAGE OPERATIONS ON DOWNSTREAM WATER QUALITY

Under the present mode of operation, releases at Otter Brook equal inflow except during flood storage periods when minimum outflow is limited to about 10 cfs. Under the drought contingency plan, filling of the drought storage pool would likely occur in May and June upon notification of a drought emergency. A minimum release of 7 cfs, the 7-day, 10-year experienced low flow (7Q10) calculated for the months of May through June, would be maintained during the filling operation. As a natural minimum flow of that season, this release should provide downstream water quality comparable with naturally experienced conditions. Small increases in temperature and decreases in dissolved oxygen would occur during filling, but probably not enough to impair downstream aquatic habitat.

Once the pool reaches the drought storage elevation of 705.0 feet NGVD, reservoir releases would be maintained equal to inflow. Any minor water quality degradation would then be due to effects of increased storage as previously discussed. During drawdown of the drought storage pool (between July and October), minimum reservoir releases would augment natural inflow causing favorable effects on temperature, DO, and water depth in the Otter Brook tailwater.

8. CONCLUSIONS

A pool increase from 703.0 to 705.0 feet NGVD during a drought emergency would have some effects on water quality; however, these effects would likely be minor. Water quality changes that can be expected at Otter Brook Lake as a result of increased storage include higher water temperatures, lower dissolved oxygen levels, and increases in iron, manganese, phosphorus, ammonia, color and suspended solids. In consequence, the lake would be subject to a greater potential for the occurrence of localized algae blooms; however, severe algae blooms are not anticipated.

Since the water at Otter Brook Lake has been historically of high quality, effects of drought storage should be minimal. Water temperatures may increase slightly, but probably not enough to significantly impair fish spawning and growth. Also, these waters are well cushioned against increases in ammonia since levels are already fairly low, and against decreases in dissolved oxygen as levels in the surface waters are already quite high. Anaerobic conditions at the bottom of the lake may worsen somewhat, but this situation can be reduced with low level gate releases. Increases in iron, manganese and color are not expected to be high enough to be harmful to humans or aquatic life. Also, increases in suspended sediment from the newly inundated lands should be localized and not significantly change overall water quality.

Unfortunately, lake waters tend to stagnate and most water quality conditions generally worsen during droughts. This situation would happen during extreme low flow periods regardless of drought storage. If drought storage releases were made using the flood control gates in conjunction with the weir, some reduction in stagnation may occur during droughts due to discharges from the bottom of the pool. These low level releases should enhance downstream water quality since surface water temperatures would become a little cooler after mixing. Releases would always be greater than or equal to inflow, except during the drought storage pool filling operation in the spring. During filling of the drought pool, the required minimum release would be the natural minimum 7Q10 flow of the May-June season. Consequently, downstream water quality degradation due to drought storage operations is expected to be minimal.

Standard treatment processes would be necessary to use the waters of Otter Brook Lake for drinking water supply if drought storage were implemented. The State of New Hampshire, in coordination with the Corps of Engineers, should evaluate whether primary contact recreation should be allowed at Otter Brook lake during drought because of possible bacterial contamination of the drinking water supply. No treatment or restrictions on recreational use would be required for the water to be suitable for fire-fighting, irrigation, and some industrial processes.

APPENDIX D

SPONSORSHIP AND LOCAL CONTINGENCY PLANNING

State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES
OFFICE of the COMMISSIONER
6 Hazen Drive, P.O. Box 95, Concord, NH 03302-0095
603-271-3503
FAX 603-271-2867
TTY/TDD 1-800-992-3312 or 225-4033
Relay Service for Deaf/Speech Impaired

ROBERT W. VARNEY
COMMISSIONER

JOHN DABULIEWICZ
ASSISTANT COMMISSIONER

September 13, 1991

Mr. Richard D. Reardon, Dir. of Eng.
Department Of The Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, MA 02554-9149

Dear Mr. Reardon:

In response to your request regarding drought emergency planning, I am writing to express the interest of the New Hampshire Department of Environmental Services in participating in the Otter Brook Drought Contingency Plan.

Kenneth Stern, Chief Engineer, Water Resources Division, will be our Department's contact person on this plan. Please feel free to contact him at (603) 271-3406 should you have any questions.

Sincerely,

Robert W. Varney

Robert W. Varney
Commissioner

cc: Delbert F. Downing, Director
Edward J. Schmidt, Director
Kenneth Stern, Chief Engineer
Chris Simmers, Chief Planner

RWV/ns.1

P R E L I M I N A R Y   D R A F T

DROUGHT EMERGENCY WATER CONTRACT
BETWEEN THE UNITED STATES OF AMERICA
AND
THE STATE OF NEW HMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES
FOR
DROUGHT EMERGENCY WATER FROM OTTER BROOK LAKE
KEENE, NEW HAMPSHIRE

THIS CONTRACT, entered into this _________ day of __________, 19 , by and between the UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and THE STATE OF NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES, (hereinafter called the "User"); represented by ???????????.

WITNESSETH THAT:

WHEREAS, pursuant to Public Law 97-228, the Congress approved the Flood Control Act of 3 September 1954, the Government has constructed and is operating Otter Brook Lake , (hereinafter called the "Project"); and,

WHEREAS, Section 6 of the Flood Control Act of 1944 (Public Law 78-534), as amended, provides that the Secretary of the Army is authorized to make contracts with states, municipalities, private concerns, or individuals, at such prices and on such terms as he may deem reasonable, for domestic and industrial uses for drought emergency water that may be available at any reservoir under his control provided that no contracts for such water shall adversely affect the existing lawful uses of such water; and,

WHEREAS, the User desires to contract with the Government for the privilege of withdrawing drought emergency water from the Project;

NOW, THEREFORE, the parties do mutually agree as follows:

ARTICLE 1

Water Supply and Withdrawals.

a. The Government will reserve 160 acre feet of storage space in the Project in order to meet the water demands of the User. From this storage space the User shall have the privilege of withdrawing all of the water in the said storage space during the term of this contract as specified in Article 6 hereof. In the event the user needs an amount of water in excess of the aforesaid 160 acre feet the government shall determine if releases in excess of 160 acre feet are feasible in accordance with paragraph 8 of Exhibit A.

b. The User shall have the right to construct, operate and maintain installations and facilities, or to contract with third parties therefor, for the purpose of withdrawing water from the Project, subject to the approval of the Contracting Officer as to design and location of such installation and facilities. All costs associated with such installations and facilities or any modifications thereof or any future construction in connection therewith, shall be without expense to the Government.

c. The Government reserves the right to maintain at all times minimum downstream releases through the gates or spillway of the dam to meet established water requirements. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

d. The User recognizes that this contract provides storage space for raw water only. The Government makes no representation with respect to the quality or availability of water and assumes no responsibility therefor, or for treatment of the water. The water level of the Project will be maintained at elevations which the Government deems will best serve the authorized purposes of the Project, and this contract shall not be construed as giving the User any rights to have the water level maintained at any elevation. The User further recognizes that it is acquiring no permanent right to the use of storage in the Project.

e. The parties agree that any actions by the Government to store waters and any rights to releases of said stored water shall be governed by the provisions of a document entitled DROUGHT CONTINGENCY PLAN OTTER BROOK LAKE dated ???? and appended hereto as Exhibit A. The said document consisting of the report and appendices A through D are hereby incorporated into this agreement by reference.

ARTICLE 2

Metering

For the purpose of maintaining an accurate record of the water released from the Project, the Government agrees to maintain records of the releases made. Such records shall include, at a minimum, the time of each release and the amount of each release.

ARTICLE 3

Federal and State Laws

a. The User shall utilize the water withdrawn from the Project in a manner consistent with Federal, State, and local laws.

b. The User furnishes, as party of the contract, an assurance (Exhibit A) that the User will comply with Title VI of the Civil Rights Act of 1964 (78 Stat. 252; 42 U.S.C. 2000d, et seq) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations. The said assurance is attached hereto and incorporated by reference.

c. Any discharges of water or pollutants into a navigable stream of tributary thereof resulting from the User's facilities and operations undertaken under this contract shall be performed only in accordance with applicable Federal, State and local laws and regulations.

ARTICLE 4

Regulation of the Use of Water

The regulation of the use of and water rights needed for the water withdrawn or released from the storage space shall be the sole responsibility of the User and under the sole authority of the User in accord with Federal, State, and local laws and shall not be considered a part of this contract. The Government shall not be responsible for the use of water by the User, nor will it become a party to any controversies involving the water use, except as such controversies may affect the operations of the Project.

ARTICLE 5

Consideration and Payment

(a) In consideration of the right to make withdrawals from the Project for municipal and industrial water supply purposes, during periods of drought emergency as defined below the User agrees to pay the Government the sum of One Dollar ($1) per year. This payment is due within thirty days of the effective date of this contract. The agreed fee for the 160 acre feet stored for the user is $2,614. This payment shall be due and payable in full within thirty days of the declaration of a drought emergency by the Governor of Connecticut subsequent to the first drought of the five year contract period. The fee per acre foot for those amounts of water released in excess of 160 acre feet shall be computed by dividing 160 acre feet by the current rate for that amount of water and multiplying the result by the quantity of water in excess of 160 acre feet released to the user.

(b) The repayment amount(s) shown in Article 5(a) is based upon those factors set forth in Appendix B attached to Exhibit A.

(c) If the User shall fail to make any payment under this contract within thirty (30) days of the date due, interest thereon shall accrue at the rate as determined by the Department of Treasury; Treasury Fiscal Requirements Manual (1 TFRM 6-8000, "Cash Management") and shall compound annually from the date due until paid. This provision shall not be construed as waiving any other rights the Government may have in the event of default by the User, including but not limited to the right to terminate this contract for default.

ARTICLE 6

Duration of Contract

This contract shall become effective as of the date of the approval by the Contracting Officer, and shall continue in full force and effect under the conditions set forth herein, for a period of not to exceed 5 years from the said date of approval. Upon expiration, this contract may be extended by mutual agreement for additional periods of not to exceed 5 years each. All such contract extensions shall be subject to recalculation of reimbursement and other fees.

ARTICLE 7

Termination of Contract

a. Either party may terminate this contract and the privilege of withdrawing water upon 30 days written notice. In the event of termination under this paragraph, the Government will make pro rata refund for any balance of the contract term for which payment has been made and the User will pay all charges which have accrued through the date of the termination.

b. The Government may terminate this contract and the privilege of withdrawing water upon ninety (90) days written notice, if the User shall default in performance of any obligation of this contract. Upon such a termination, User shall continue to be liable to the Government for any monies owned and for any costs incurred by the Government as a result of the default.

c. In the event of any termination pursuant to this Article or Article 6, User shall, upon request of the Contracting Officer, promptly remove, at User's own expense, any facilities constructed on Project land for water withdrawal and restore premises around the removed facilities to a condition satisfactory to the Contracting Officer.

ARTICLE 8

Rights-of-Way

Occupancy and use of Project lands shall be in accordance with any permits, rights-of-way, or easements granted to the User by the Government.

ARTICLE 9

Release of Claims

The User shall hold and save the Government, including its officers, agents, and employees, harmless from liability of any nature or kind for or on account of any claim for damages which may be filed or asserted as a result of the withdrawal or release of water from the Project made or ordered by the User, or as a result of the construction, operation or maintenance of any facilities or appurtenances owned and operated by the User except for damages due to the fault or negligence of the Government or its contractors.

ARTICLE 10

Transfer or Assignment

The User shall not transfer or assign this contract nor any rights acquired thereunder, nor suballot said water or storage space of any part thereof, nor grant any interest, privilege or license whatsoever in connection with this contract, without the approval of the Secretary of the Army or his duly authorized representative provided that, unless contrary to public interest this restriction shall not be construed to apply to any water which may be withdrawn or obtained from the water supply storage space by the User and furnished to any third party or parties or to the rates charged therefor.

ARTICLE 11

Officials Not to Benefit

No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

ARTICLE 12

Covenant Against Contingent Fees

The User warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the User for the purpose of securing business. For breach or violation of this warranty, the Government shall have the right to annul this contract without liability, or in its discretion, to add to the contract price or consideration the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 13

Environmental Quality

During any construction, operation, and maintenance by the User of any facilities, specific actions will be taken to control environmental pollution which could result from such activity and to comply with applicable Federal, State and local laws and regulations concerning environmental pollution. Particular attention should be given to (1) reduction of air pollution by control of burning, minimization of dust, containment of chemical vapors, and control of engine exhaust gases, and of smoke from temporary heaters; (2) reduction of water pollution by control of sanitary facilities, storage of fuels and other contaminants, and control of turbidity and siltation from erosion; (3) minimization of noise levels; (4) onsite and offsite disposal of water and spoil; and (5) prevention of landscape defacement and damage.

ARTICLE 14

Approval of Contract

This contract shall be subject to the written approval of the Secretary of the Army or his duly authorized representative and shall not be binding until so approved.

IN WITNESS WHEREOF, the parties have executed this contract as of the day and year first above written.

APPROVED:	THE UNITED STATES OF AMERICA
______________________________	By ___________________________ (Contracting Officer)
DATE: __________________	[Insert name of User} By ____________________________ [Title]

STATE OF NEW HAMPSHIRE EMERGENCY CONTINGENCY PLANNING

The New Hampshire Drought Management Plan (DMP) was completed by the Department of Environmental Services Water Resources Division in conjunction with DMP Task Force in May 1990. The document provides guidance for..."statewide application and (is) capable of addressing significant issues of local concern." (page i).

AUTHORITY

The following authority for the DMP has been extracted from page I-4 of the DMP as follows:

"The primary source of authority for implementing drought response rests with the Governor's Emergency Powers under RSA 107-C:4. This statute creates the Emergency Management Agency which has broad authority in all forms of emergencies. Auxiliary authority exists under other jurisdictions for responses specific to that jurisdiction.

The Department of Environmental Services Water Resources Division has authority under RSA 482:2 to direct dam owners to store or release waters in response to emergencies where the public health or safety may be jeopardized.

The Department of Environmental Services Water Supply and Pollution Control Division has the authority under RSA 148:22 to require public water suppliers to develop drought contingency plans for their particular system.

The Public Utilities Commission has authority which can be exercised relative to the operation and management of utilities in times of emergencies.

Local governing bodies including cities, town and village districts have numerous powers which can be exercised to protect the public health and welfare."

A decision to commence storage for emergency water supply at Otter Brook Lake would therefore require the concurrence of both the New England Division of the Corps of Engineers and the Department of Environmental Services Water Resources Division.

ADMINISTRATION

From a state-wide perspective, three administrative units have been created for the establishment and implementation of the Drought Management Plan: the Task Force, the Drought Management Team and the Executive Committee.

Task Force

The Task Force was established with the specific responsibilities to:

- identify agencies and/or people with the experience, jurisdiction and authority to perform specific functions.

- establish drought management areas (DMA) based on generally similar severity of and impacts from droughts. Keene is in South Western DMA #3. (See Attachment)

- establish the detection and monitoring plan and the response plan.

After the completion of the plan, the task force was disbanded and responsibilities transferred to the other two administrative units.

Drought Management Team

The Drought Management Team (DMT) is represented by the following agencies and water interests with responsibility for responding to droughts or other events causing water shortages.

Governor's Office
    Office of Emergency Management
    Office of State Planning

Dept. of Environmental Services
    Water Resources Division
    Water Supply and Pollution Control Division

Dept. of Agriculture
Dept. of Health - Division of Public Health Services
Dept. of Resources & Economic Development
N.H. Municipal Association
N.H. Water Works Association
N.H. Business & Industry Association

The DMT is convened at the discretion of the Executive Committee. The DMT confirms the existence and stage of drought or water shortage.

Executive Committee

The Executive Committee consists of selected members of the DMT. The committee monitors hydrologic conditions directly and by reviewing reports of water users and agencies such as the U.S. Weather Bureau and Geological Service. The committee issues drought notices and convenes the DMT as conditions dictate including the needs of water users. The Executive Committee is composed of individuals from the following agencies.

Director of Emergency Management
Director of State Planning
Commissioner of Environmental Services
Director of Water Resources Division
Director of Water Supply and Pollution Control Division

During the preparation of the Drought Management Plan, task force members could not agree on the advantages of having the governor designate an individual from the DMT to make decisions under emergency powers provisions on the part of the State of New Hampshire. Since the authority to direct dam owners to store or release waters in response to emergencies has been given to the Division of Environmental Services Water Resources Division, NED would coordinate closely with the Division.

DETECTION/MONITORING

The Drought Management Plan recognizes the need to establish triggers to signal different levels of severity of drought or water shortage based on monitoring precipitation, stream flows, ground water levels, soil moisture, reservoir levels, and social and economic impacts. The Task Force, however, was unable to specify indicators for drought stages. The Department of Environmental Services presented threshold values in order to guide the DMT in declaring a particular drought stage. The impacts of the severity and duration of droughts have been conceived at four levels.

Level 1	Alert	(inception)
Level 2	Warning	(moderate)
Level 3	Emergency	(severe)
Level 4	Disaster	(extreme)

Levels 1 and 2 and levels 3 and 4 are approximately equivalent respectively to NED's Drought Water Phase and Drought Emergency Phases.

Different water use interests would be impacted differently by the severity and duration of drought or other water shortages. Here we address the City of Keene as a public water supplier.

RESPONSE

The Drought Management Team provides oversight, general guidance and coordination of the drought response process. The individual water users (public water suppliers, and municipal waste discharges, and the agricultural, industrial, power production and recreational groups) have the fundamental responsibility for their responses to water shortages. The following has been extracted from the NH Drought Management Plan (page IV-1).

"In general, the level of response corresponds with the stage of the drought.

LEVEL 1 Alert

At this level a detailed assessment of hydrologic conditions relative to a specific source or use should be conducted if not already done. This assessment should include a projection into the future to determine the potential need for voluntary or mandatory action.

LEVEL 2 Warning

Voluntary water conservation measures are initiated to prevent serious shortages. Investigation of potential source augmentation may be undertaken. The need for mandatory action is evaluated.

LEVEL 3 Emergency

Mandatory water conservation measures are implemented. Generally these conservation measures relate to nonessential water use.

LEVEL 4 Disaster

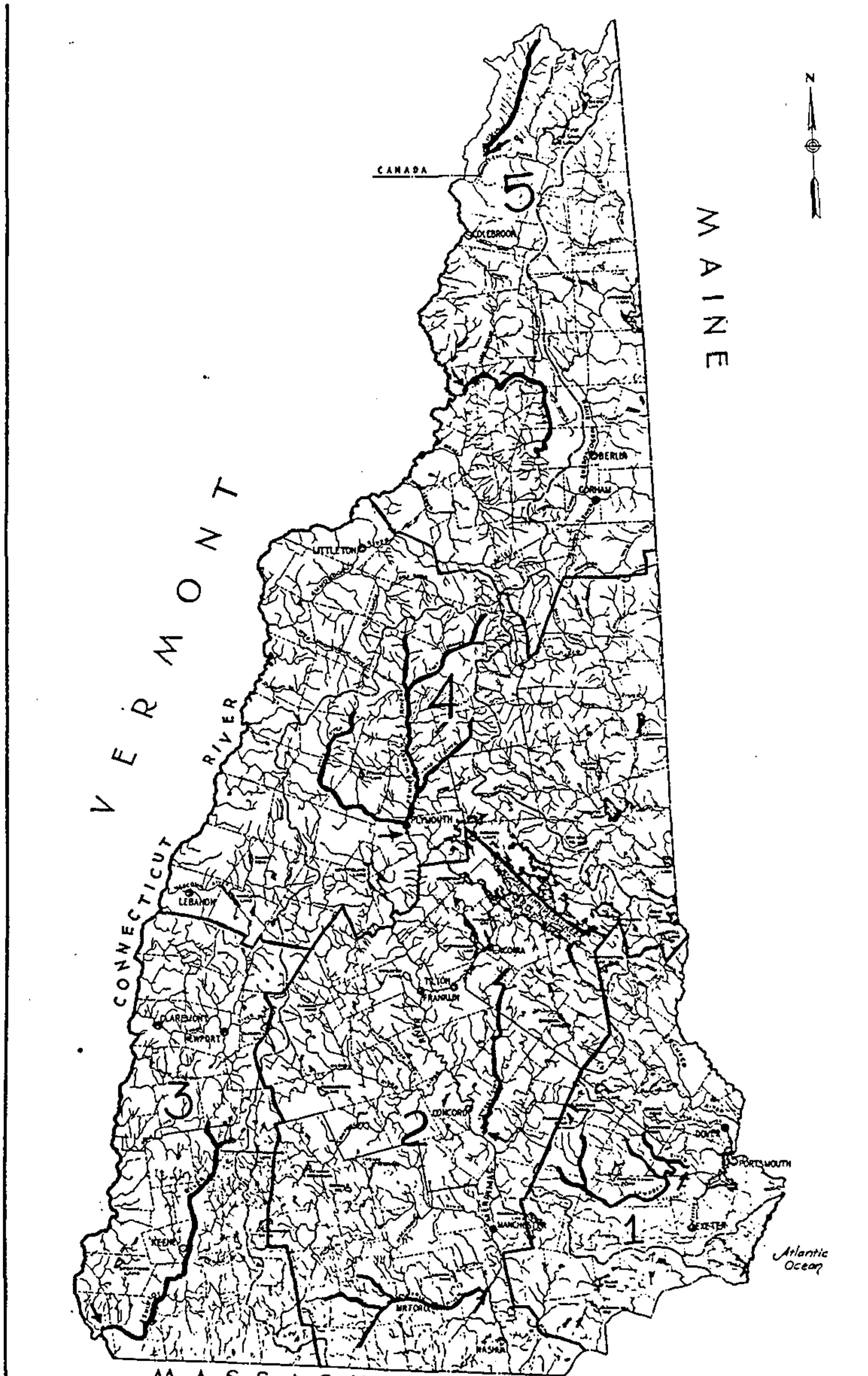
At this point, water use restrictions may be imposed which have significant economic implications. Emergency powers of the Governor may be exercised to mitigate severe local impacts."

Public Water Suppliers

A representative from the public water supply group would be part of the Drought Management Team. With respect to public water suppliers, the Drought Management Plan recognizes that each system should have its particular monitoring and response plan tailored to local conditions and related to the four previously defined stages of drought.

City of Keene, New Hampshire

The city of Keene, N.H. has not yet established a drought contingency plan for its water supply system. As a component of its water supply master plan, the city is currently investigating the possible use of Otter Brook Lake for seasonal and emergency water supply. The study would evaluate the feasibility of accessing releases from Otter Brook Lake. If the use of the Lake for emergency storage is found to be feasible, the City of Keene would then propose a drought contingency plan based on using storage from Otter Brook Lake.



DROUGHT MANAGEMENT AREAS

INDICATOR STREAM FLOW GAGES

SOURCE: New Hampshire Department of Environmental Services, New Hampshire Drought Management Plan, May 1990, page C-2.